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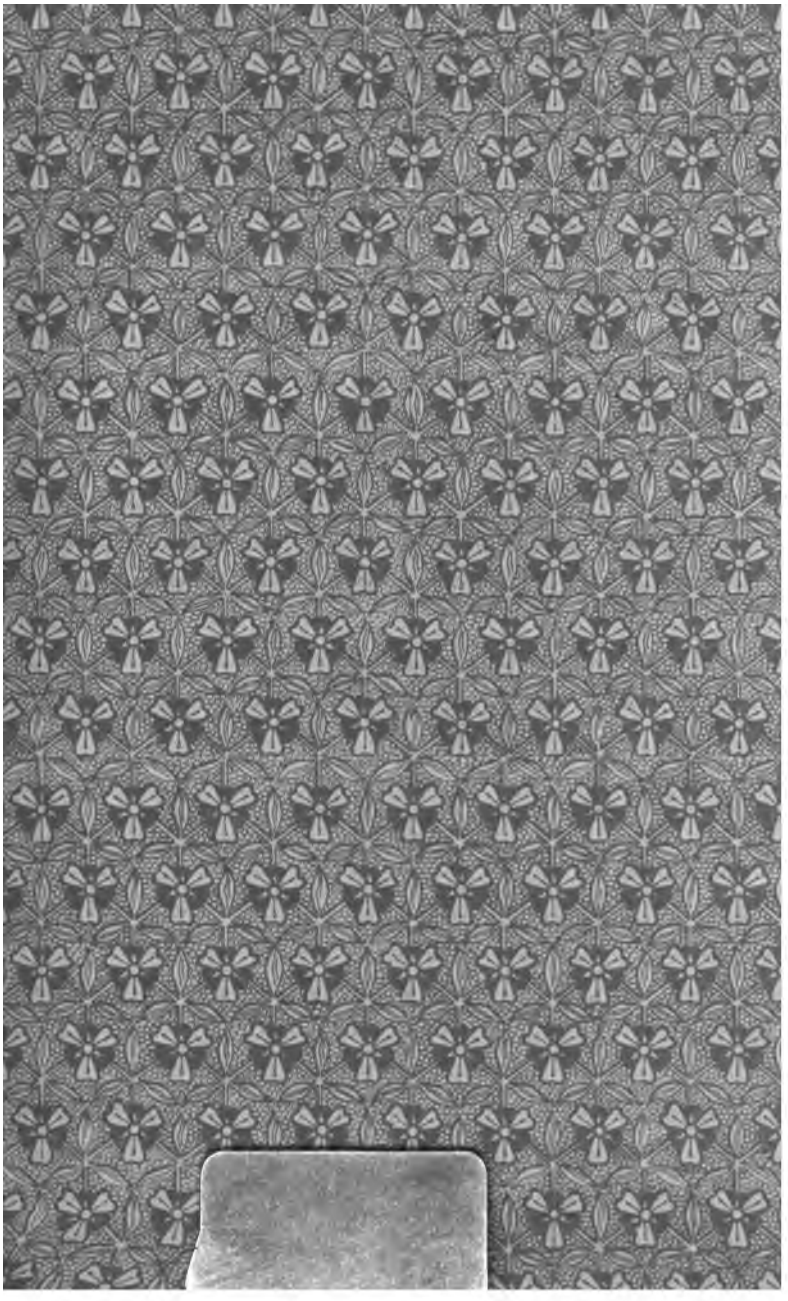

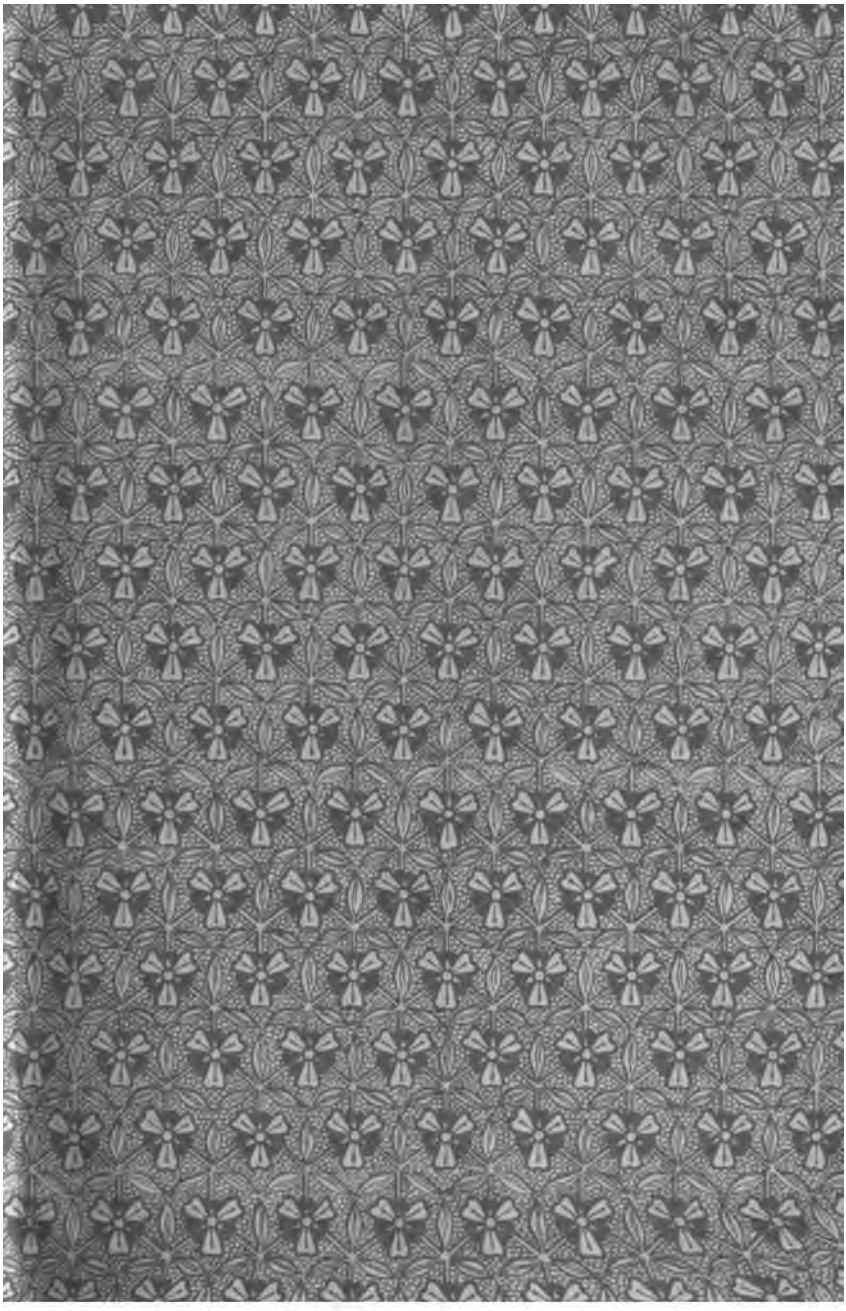

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SALMON PROBLEMS.

SALMON PROBLEMS

BY

J. W. WILLIS BUND,

CHAIRMAN, SEVERN FISHERY BOARD.

LONDON:

SAMPSON LOW, MARSTON, SEARLE, & RIVINGTON,

CROWN BUILDINGS, 188, FLEET STREET, E.C.

1885.

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LONDON, W.C.

PREFACE.

MY object in writing this book was, if possible, to obtain some reliable information on the different questions relating to Salmon that are mentioned in it. I am not sure if the chief result will not be to expose my own ignorance, but if even by that means the problems can be satisfactorily solved, I shall be quite content.

I ought to add that my personal experience of the habits of Salmon has been almost exclusively derived from the Severn, and one or two Welsh rivers, and that I have no personal knowledge of the habits of the fish either in the northern or southern rivers of England. The observations on those rivers may differ entirely from anything I have heard of. When I have referred to them in the following pages, it is usually from the facts stated in the Inspectors' Reports.

It only remains for me to express my thanks to various friends and correspondents who have helped me with notes and information as to the result of their observations on the habits of Salmon, and chief among them are Mr. Berrington, the Chairman of the Usk Board, who has given me the Annual Reports of that Board, and Mr. Alfred George, the Superintendent of the upper part of the Severn district, who has furnished me with much information as to the facts that, during eighteen years experience in the upper Severn, he has observed in connexion with Salmon. I have also obtained much valuable information from the late Mr. Buckland's official reports.

WICK EPISCOPI, WORCESTER,
August, 1885.

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SALMON PROBLEMS.

CHAPTER I.

INTRODUCTORY.

IN July, 1860, a Royal Commission was appointed to inquire into "the Salmon Fisheries of England and Wales, with the view of increasing the supply of a valuable article of food for the public." The Report, dated February 7, 1861, found the fisheries "to be in a state of lamentable depression," and the evidence taken by the Commission exhibited "many erroneous opinions respecting both the nature and habits of the Salmon, and the true interests of those who preserve and claim rights to the fisheries." The Report was followed by the Salmon Fishery Act, 1861, which may be shortly described as extending to England the law that then prevailed in Ireland. The wisdom of the measure as a whole has been justified by its results: the fisheries have been raised from the lowest state of depression into an important source of food supply. Whether they have been made as productive as they might have been, whether the system now adopted in many rivers is the right one, is an

open question ; but it would be idle to deny the great progress that has been made. A certain point has been attained, but it seems doubtful if the fisheries are still increasing beyond this point ; whether at the present time they are progressing or only stationary, or not even declining. The improvement caused by the Act of 1861 was by the application of three cardinal principles. 1. Free passage for the fish from the sea to the head of the river at all times. 2. Protection of the fish, absolute during close-time : limited during the open time. 3. Pure water. These principles apply equally now as they did in 1861 : without them any improvement is impossible. Their practical application at first was very easy. Erect fish-passes over the weirs that hinder the ascent of the fish ; stop the capture of fish in close-time ; prohibit at all times the use of improper means of taking fish. This was the whole duty of a Conservator, and it was simple : he had only to carry out these rules. The law enabled him to build fish-passes, it gave him power to stop fishing in close-time, it specified certain instruments that were not to be used at any time. Fish-passes were built, but the Salmon did not use them, and in some degree poaching was stopped. In 1873, Parliament, in its wisdom or unwisdom, gave to Boards of Conservators more extensive powers ; they were no longer merely executive officers to carry out certain fixed and definite orders, they were entrusted with the power of framing the orders they had to carry out. Each

person considered he knew what was best for each river; but each considered that to be best for the river that was, in his opinion, best for himself, and hence bye-laws were made and rules laid down in many cases undoing the work that had been done. This state of things still continues. It is mainly founded upon the fact that the universal ignorance as to the habits of Salmon is universally shared by Boards of Conservators. There are forty-five Fishery Boards in England and Wales, numbering over 1000 members. It may be doubted if among them there are fifty persons who have any practical knowledge of the habits of the Salmon, or of the subject on which they are legislating. Unfortunately the Boards are not put in the right track by the central authority. Although the greatest living biologist is Inspector of Fisheries, except on the subject of Salmon disease there are not in his Reports any indications that he is endeavouring to collect materials for the scientific history of the Salmon fisheries, or of solving those questions that are met with on every side.[1] The Inspector's Reports are usually framed in this way. In the autumn of the year, a series of fifteen questions are sent to the forty-five clerks of the Fishery Boards. They vary a little from time to time, but are practically the same in each year. The first three relate to the take of fish in the district during

[1] Since this was written the Twenty-fourth Report of the Inspector has appeared, which contains some discussion as to early and late rivers. This may be said to be an exception.

the year; then comes the only scientific one, introduced, it is true, under Mr. Huxley's auspices: "Has Salmon disease appeared? if so, state full particulars." Two questions follow as to weirs and fish-passes, two as to pollutions, three as to the licences issued; then lists of the prosecutions are asked for, then, "Is illegal fishing prevalent? How many water-bailiffs do you employ? Have any gratings been erected? What are the names of the Chairman and clerk?" the cream of the answers to these questions, and the accounts of the visits (if any) the Inspector has paid to the districts during the preceding year, with a summary of the Reports of previous inspections for some years back in relation to a particular river, or rivers; an appendix, consisting of the queries and the answers; and some tables compiled from the answers for preceding years form the Inspector's annual Report. It is open to doubt if this is what the legislature intended when it enacted that "The Home Office shall annually lay before Parliament Reports from the Inspectors, which Reports shall contain, as far as may be practicable, a statistical account of the fisheries, with such other information as may be collected, and suggestions offered for their regulation and improvement;"[1] or what it contemplated when it prescribed "That the clerk of the Board shall prepare an annual return, containing such information as the Secretary of State shall from time to time

[1] 24 and 25 Vict., c. 109, sec. 32.

require."[1] The result of such Reports is to impress upon Fishery Boards, that if not their whole, at least their chief duty consists in two things—raising as large a revenue as possible; catching as many fish as possible; so that their answers to the Inspector's queries may form a basis for the Inspector to give a rose-coloured report of the state of the fisheries. It is true that Mr. Huxley in his last three reports has pointed out "the importance of the observations upon the natural phenomena affecting the fisheries," and "suggested that it would be very desirable that accurate records of the state of the weather and other circumstances should be kept, in order to trace the effects of meteorological conditions upon the fisheries, not only on the particular season to which the records apply, but of subsequent years;"[2] and in his last report expresses a hope "that Conservators and others will institute observations on points connected with the natural history of the Salmonidæ, about which our knowledge is still far less exact than it ought to be."[3] But it does not appear that he has taken or initiated any steps to carry out these suggestions. The Usk is the only Board that, up to the present time, has done anything in the way of scientific research, or kept an accurate record of facts relating to the history of Salmon;[4] in fact, it is the only Board that has been officially asked or encouraged to do so.[4]

[1] 36 and 37 Vict., c. 71, sec. 63.
[2] Twenty-third Report, p. 5. [3] Twenty-fourth Report, p. 37.
[4] See Inspectors' Circular to the Usk, Appendix B.

Yet it is only by means of knowledge acquired from the facts collected by those who observe the habits of the fish that the knowledge upon which the true rules for the development of our fisheries is to be based can be obtained. Since Mr. Buckland died it seems to be no one's business to collect the various facts relating to Salmon that are reported from time to time. He used to consider no fact to be too small to be noted, and he certainly compiled more information than any one has done, before or since, as to the habits of fish. His contributions to *Land and Water* give his views on the mass of matter he collected from all parts of the country, and are almost the only record of the habits of fish during the years they cover. Unfortunately his facts are not so useful as they should be, for he noted down everything he was told, whether true or false, and from each of the facts so noted he constructed a theory as to Salmon preservation.

It is much to be desired that some system of recording year by year all the information that can be obtained as to our fisheries should be devised; at present we are wholly in the dark on many of the most important questions connected with the natural history of the Salmon. Except that we have found out, or imagine we have found out, that some theories that used to be held are untrue, our knowledge as to habits of Salmon is much in the same state as it was fifty years ago, and each year is allowed to go by and no reliable data are collected

that may serve to give us any knowledge in the future. Knowing nothing, we take no means of acquiring knowledge, but go on making rules and laws for the development of the fisheries, and wonder that the fisheries do not improve, when we are quite in the dark on the subject to which our legislation applies, and what will be the effect of our legislation.

A movement was made last year (1884), for forming a Society for Biological Investigation of the Coasts of the United Kingdom, and in the speech Mr. Huxley made on that occasion he put the case so strongly that it will be well to give his words:—

"In order to understand the living being now, it is no longer sufficient to be acquainted with its outside, as in the days of our forefathers, or even with its inside, so far as obvious anatomy is concerned, as was the case with the immediately preceding generation. We now, in order to understand the living relations and affinities of an animal, have to go back through the whole course of centuries beyond, in order to trace out the successive stages of development from the eggs, and this can now be done with a precision and accuracy which, in my young days, we had no conception of. But though, from a purely scientific point of view, there is one great reason for establishing laboratories of the kind now proposed, a more decidedly practical reason exists. We possess great fisheries, which are more or less regulated by legislation, and which are of great importance to very large masses of the population. Hitherto, certainly

within the last thirty years, such regulations were made in an almost entirely haphazard manner, because of the want of knowledge of the habits, the mode of life, and the mode of production, &c., of the animals economically useful. At the present time it is within my knowledge that a great deal of vehement opposition to particular modes of fishing has been due to the absolute ignorance of the fishing population of some of the primary facts of the mode of life and reproduction of our food fishes; and it is of essential importance that those who wish to regulate fisheries should rest their arguments and their warnings upon a definite and solid foundation, and upon a complete knowledge and sound observation of the modes of life, and development, and so forth, of the animals which contribute the staple of our fishery wealth." [1]

It is impossible to put the case more forcibly than it is here stated, and the only thing to be regretted is that Mr. Huxley does not use his position as Inspector, and the powers attached to it, for the collection of the information necessary for the purpose.

The history of the fish that migrate into the fresh waters of England and Wales is a much smaller subject than that for which the Plymouth laboratory is founded, but it is no less important, and it may be hoped that before long it will be considered worthy

[1] Speech of Mr. Huxley at the meeting for founding the Society, March 31, 1884, p. 4.

of notice. There are numbers of persons who would help to observe the habits of fish if they only knew how and what to observe. Nothing is more popular than fish and fishing, and the popularity is increasing. In the Severn fishery district alone there were, last year, 7,000 anglers, many of whom could contribute some fact that has come within their knowledge—some observation they may have made, that, if recorded, might help to increase the knowledge of fish, or point out the right path to obtain an increase of knowledge. No opportunity should be lost. Last December, by accident, I acquired an important bit of information as to samlets. A man asked me to look at the eels he had caught the previous night. I looked in his boat, and saw, not merely eels, but another fish that looked like a samlet. On fishing it up, it turned out not only to be a samlet, but also to have on the silvery scales that samlets assume on their seaward migration. The man said he had caught it with a lot of others in an eel net the previous night. On questioning other fishermen they also admitted catching smolts on the previous night, and, on examining the boat, one or two were found. An autumn migration of smolts is a thing hardly ever heard of; indeed, its existence is denied. Yet, here it was, and, but for the merest accident, would have passed by unrecorded. Of course this one isolated instance means nothing, but it gives rise to inquiries as to whether an autumn migration is a regular thing or not. The importance of it to Fishery Boards is

considerable. To give an instance: They have power to make bye-laws to determine the times of the year at which gratings shall be placed at the head of channels to prevent smolts being led astray on their seaward migration. Almost invariably these bye-laws have prescribed that it is only necessary to maintain these gratings in the spring. If, however, there is such a thing as an autumn migration, equal necessity exists for maintaining the gratings in the autumn as well as in the spring. Observation can alone settle this point.

It has already been stated that the Salmon Fishery Act of 1861 practically introduced into England the law that was in force in Ireland. As this was done without any consideration as to the different conditions as to rainfall and climate in the two countries, it produced in England some effects that were not intended by its framers. Owing to the greater rainfall, the Irish rivers are not, it would seem, so subject to great variation in the volume of the water as the English; the height is much more uniform, and rules that could, from the more regular supply of water, be well carried out there, were wholly unpracticable in this country. The adoption of the Irish laws led by accident to one of the greatest improvements in the English fisheries, but to a confiscation of very valuable property. In many of the Salmon rivers, at each mill was a Salmon trap, which caught, indiscriminately, ascending and descending fish. Some of these rights were very ancient and very valuable, and any attempt

to do away with them without compensation would have been resisted to the last, and would have wrecked the Bill. In Ireland it was the law that all these traps should only be used if there was a fish-pass with a constant supply of water flowing through it attached to the dam. This could be done with comparative ease in the Irish rivers; it was physically impossible in almost all the English and Welsh streams. Although there would be plenty of water at the time the fish usually wanted to travel, yet in the Welsh mountain streams there were days when there would not be a drop. The Irish law was incorporated into the English Act, and as it was utterly impossible to comply with its conditions, these most objectionable forms of taking fish were got rid of.

Another section of the Act of 1861, copied from an Irish Act, did not work so well, and is, from the altered circumstances of the case, positively injurious in many instances to the English fisheries. The section is the 26th: it provides the sluices in any dam are to be kept closed when the water is not wanted for milling purposes, so as to send the water through the fish-pass. In a large river, with plenty of water always going over the dam, and making a strong current to bring up the fish to its foot, it would work with good effect, for then, without some such provision, the miller would raise his sluices so as to let down the water below the level of the fish-pass, and keep the fish congregated at the bottom of the dam, and unable to get up higher, a device which

in Ireland is very properly prohibited. But circumstances alter cases, and the way this clause works in the English and Welsh rivers in many cases is really hurtful to the fisheries. On Sunday, the mills not being at work, and no water coming over the dam, if the sluices are kept shut the river below the mills is nearly dry, and the fish are left in the pools with very little water, to fall a prey to the first man who has a gaff. In the interests of Sunday sport and destruction of fish nothing better than this clause could be devised; but the legislature intended the clause to ensure the passage of Salmon up the river, while, from the ignorance of natural causes, it really ensures their falling a victim to the poacher. No member of Parliament considered it worth while to point out, even if he knew, the difference between the English and Irish rainfall, and the difference between the volume of English and Irish rivers. But the clause is harmful in another way. Some years ago I was, one Sunday in May, with the late Mr. Buckland, and went with him to a weir in the Severn district. No water was passing over the dam, and the sluices were close shut. Looking into the clear water above the sluices, we saw five or six kelts. The miller, who was with us, told us there had been more, but, as the water was low, and they could not get down to the sea, they had died; and he took us to see the body of one he had lately got out, which had been some time dead, and on which Mr. Buckland at once held a *post-mortem*, and

mourned the loss of so fine a fish. Turning to the miller, he said, "If you pulled up the sluices the fish would go all right?" The miller agreed. "It would not hurt your milling power to do so?" The miller again agreed. "Then why don't you?" said Mr. Buckland. "Because there is a fine of five shillings per hour for doing so." Mr. Buckland was for pulling up the sluices and risking the penalty; but I had to ask him, as I have had to ask other Inspectors since, to show me the clause in the Salmon Fishery, or any other, Act, which authorises Inspectors to dispense with the law. The miller also protested that he, and not Mr. Buckland, would be liable to the penalty.

This furnishes an example of a clause being inserted, with the best of intentions, in an Act of Parliament, which is still law, but which is absolutely mischievous, and this owing to ignorance of the variation of the different natural characteristics of different places.

Another example, for which I am alone responsible. The Salmon Fishery Act of 1873 had prohibited the capture of elvers.[1] This provision caused great dissatisfaction, and in 1876 it was repealed;[2] but as to the Severn, a partial close-time was preserved. There was considerable question as to what the close-time was to be, and I was asked by the Home Office to fix the proper dates. But I did not like to trust

[1] Sec. 15.

[2] 39 and 40 Vict. c. 34.

to my own knowledge alone. I questioned all the fishermen and persons I could find, and got all the best information I could, which was, that elvers never ascended the rivers much after the 1st of June. If the 24th of June was inserted, it would meet the case, and do all that was wanted; and I was rather blamed by some persons for taking more time than was necessary. The Act passed in 1876. In June, 1877, the elvers, whether in spite or not it is hard to say, did not run in any quantity until the last week in June! Had there been anything like a reliable series of observations on the migration of eels such a blunder would not have been made.

Another instance. By a bye-law Conservators have power to prohibit fishing within a certain distance of the mouth of streams. After a good deal of discussion a bye-law was passed, prohibiting fishing for Salmon within a certain distance of the mouth of a particular stream. I went soon after to visit the spot to ascertain how the distance should be marked, and found that no Salmon had within the memory of man been known to ascend this stream! Instances might be multiplied to almost any extent, showing that with the best intentions both the legislature and the Fishery Boards have framed laws that are not only useless, but also absolutely hurtful. The only remedy for this state of things is to obtain a more accurate knowledge, or, to speak more correctly, some accurate knowledge, of the subject legislated upon, and to do this requires a series of observations taken

over as wide an area as possible, in order to answer certain questions. Government, as shown from the above-quoted reports and speech of the Inspector, are fully aware of the necessity for this, but they have taken no step, and as far as appears will take no step, to supply this want with regard to the English and Welsh fisheries, although a step in this direction has been made this session with regard to the Scotch sea fisheries. By the Act just passed, the Sea Fisheries, Scotland Amendment Act (1885), the Scotch Fishery Board is given power to make experiments, in order to answer certain questions as to sea fisheries. As we have allowed the whole question of research into the sea fisheries to remain in private hands, it is idle to expect that we will undertake the smaller question as to the freshwater fisheries.

As Government will not take up the matter, it rests either with the Fishery Boards or with private individuals to do the work. Most of the Fishery Boards have no money, and, I am afraid, little inclination, and are more than fully occupied with the work that the law has already entrusted to them, and regard the scientific side of the fishery question as quite beyond their duties. There only remain private persons, and although there are a number of persons who have both leisure and ability to help, yet, for some reasons, questions connected with fish receive little or no regular attention. No one can read the *Field*, *Land and Water*, or any of the country papers, with-

out seeing the great interest that is shown in catching fish, and the zeal that is displayed by various theorists in advocating their special theories; but anything like the systematic collection of observations, so as to enable some real light to be thrown on the habits of fish, and the true laws for their preservation to be discovered, is conspicuous by its absence. No one will dispute the importance of such observations: will no one help to make them? The information required is of two kinds. The first as to the habits of the fish, and this can be obtained by almost any one who will take the trouble. A walk by the river will often furnish some one fact that may be valuable. For example, it is important to know the earliest date at which Salmon begin to spawn. Any one walking along a river in October and November could ascertain if the fish were on the beds or not. In the spring, a walk by the river will often show if there are any diseased fish about, and the dates of the appearance or disappearance of the disease; the number of fish affected by it, and the number dead, are all points worth noting. So again, the number of Salmon at a weir in the autumn, the time when they have arrived, the height and the state of the water that has brought them up, and the height and state of the water when they are able or unable to pass over it, are all valuable. The migration of smolts seaward is easily noted, and the dates are of importance, for although the time at which the majority go down is well known ("the first flood in May takes the smolts away"),

yet the question if there are not successive migrations is one to be answered. No fact connected with fish is too trivial for notice, and if only those who enjoy—and who is there who does not?—a stroll by a river at any time of the year would try and observe all that they can see, and note what they do, our ignorance on the life and habits of fish, especially migratory fish, would not be so dense as it now is. Anglers, again, can do much; it is not the take of fish that is so important and deserves special notice, nor the voracity of the fish, nor the mighty fishing feats—we often hear of them: they are all very well in their way—but some notice of the food of migratory fish, of the time of their appearance, of their habits in fresh water, are infinitely more important. The desire to kill fish may be the motive that takes one to a stream, but it should not be allowed to be the only object of every one when he gets there. The faculty of observation will not only help an angler to kill fish—it may be said without it he never will kill any—but it may also enable him to do some service to the cause of the fisheries.

The foregoing class of observations only require a little care and trouble; any one can make them, and those who only get sight of a river once or twice a year may, and very likely will, collect far more important information than those who live by a stream all their lives. The second class of observations can only be conducted by those who reside in the locality, and will give up their time and take a

considerable amount of trouble. As to the effect of rainfall and temperature on fish, on this subject we have almost no information. One of the urgent needs of fishery reformers is a carefully collected series of observations on the rainfall, temperature, and height of rivers; and this, combined with returns as to the times when the fish are there, and the quantity of fish observed at different times, will probably give some clue as to their habits and the reasons that govern fish life. For some years back, thanks to the energy of Mr. Symons, reliable observations as to the rainfall of this country have been made, but these require to be supplemented by the establishment of new stations on the different streams. No regular record as to the temperature of our streams exists, and temperature, it would seem, exercises an important bearing on the habits of fish. Authentic records of the height of rivers, and the effect of rainfall on the rivers, are also very fragmentary. To procure these records proper instruments are required, and, what is more important, accurate and continuous observations, and it is difficult to get competent persons to undertake the duty. Observations as to rainfall are not so difficult to get accurately taken as are those as to temperature and the height of the rivers. But something can be done, and, if the observations cannot be obtained as complete as might be desired, some are better than none. With the hope that some of those who have leisure and opportunities will aid in making and recording

observations, this book has been written. It does not propose to give a list of all the questions that require solution, or even of the matters that should be observed; all it does is to indicate some of the problems connected with Salmon, and to suggest certain questions, which, if they can be satisfactorily answered, would in some way tend to solve these problems, and thus furnish a reliable basis upon which both the legislature and Fishery Boards may in future act when making regulations as to our fisheries.

CHAPTER II.

SPAWNING FISH.

THE first of the great conditions for successful Salmon cultivation—good spawning-seasons—require various concurrent circumstances before they can be ensured. A proper supply of fish, suitable weather, adequate protection, are the great conditions; the last is the only one that the Board of Conservators can ensure, and it is really the least important. A good supply of fish, and good weather, even if breeding-fish are poached to some extent, will produce more Salmon than a very large supply of fish (if the weather is bad) most carefully watched. The great difficulty is not how to get the fish to the spawning-grounds, that is comparatively easy, but how to get the fish properly distributed over the ground when they have reached the upper waters. This must depend wholly upon the weather. An ideal spawning-season would be a succession of gentle freshes, so that all through the year fish would be running up; and that in the autumn there would be a large supply of fish in the upper waters; then a fresh of medium height, that would take them to the very top of the spawning-ground. These freshes would also bring up the first autumn run of fish, and it should bring them up so as to enable them to

occupy the ground just below where the others have spawned. The Christmas run of fish should follow them to still lower spawning-grounds, and a series of gentle freshes should bring up the spring spawners to the lowest beds of all; and then, not till February or March is high water wanted to take the kelts down to the sea.

There are generally four distinct groups of spawners, often more, not counting isolated fish that arrive from time to time. The first are those who have, during the summer or early autumn, worked up the river as occasion served. These spawn the first, generally on the Severn about the end of October; on the Usk it would be a little later. Then come with the fresh, late in October or November, a rush of fish; this is the second lot. The third, and often the chief lot, is what a fresh about Christmas brings up; and at the end of January, or in February, come a fourth and much smaller lot. The bulk of the fish are contained in the second and third lots. The normal state of things is, that about the end of October the fish already in the upper water begin to spawn.[1] From October 24, onwards, almost as soon as they have spawned, or while spawning, a fresh

[1] In his Twenty-fourth Report Mr. Huxley says that he "knows of no conclusive evidence that Salmon spawn earlier than November"; I do not like to say this is not so, for I do not know what Mr. Huxley considers conclusive evidence. I can only say I have in several years seen fish spawning in October, and the Severn Superintendent tells me he has constantly done so.

comes; it either interrupts the fish while spawning, and causes a good deal of the spawn to be lost, or the fish leave the beds already made, make fresh ones in places which, when the water goes down, are left dry, or else the fresh washes out the beds, and also brings up a number of fish. The chances are that these last fish will get just as high as where the other fish have spawned, and the first thing they do is to turn over the already-sown bed of the river and make new beds, thereby destroying, to a great extent, the beds already made. And so, instead of getting the benefit of the ova from each pair of fish, it frequently happens that each pair undo what their predecessors have done, and those who have seen the trout watching round the Salmon beds will agree that if the beds are stirred up little ova escapes. The Christmas run of fish rout out the beds made by the autumn run, and the spring runs often repeat this process. Unless, therefore, there are favourable waters, the result usually is that a large number of spawning-fish do not necessarily mean a good spawning-season.

If there is a weir across a river, fish can only surmount it in high flood; and, as there generally is a fine stretch of spawning-ground below a weir, unless there is sufficient water to take the new comers over a moderate number of fish is better than a very large number, as often a large supply of fish means a large loss of spawn. This view of the matter is usually overlooked, and it is stated that it is a wonderful

spawning-season, the river is full of fish; but it is never stated how the fish spawned, or whether or not the beds have been routed out over and over again.

If a large quantity of fish are spread over a large area, and do not interfere with each other, then, of course, the larger the quantity of fish the better the spawning-season; but if, either from artificial or natural causes, the fish are congregated in a small space, then it would seem that a large supply of fish does more harm than good. There are several very important points that arise for consideration out of this state of things. The most vital is, how to get the fish distributed over as wide an area as possible? and at the root of this question lies another—what is it that makes the migratory fish resort to particular spots? Every one who knows anything of the habits of Salmon is aware that there are certain favourite places to which Salmon habitually resort, while places that appear equally suitable they habitually avoid. In the Severn, the ascending breeding-fish in any quantity, as a rule, select out of all the tributaries below Shrewsbury only three, and all these on the left bank of the river—the Teme, the Dowles Brook, the Cound. It is true they are (except the last) the best adapted for Salmon, but there are others also well adapted, into which the fish hardly if ever go. Two ways of explaining it suggest themselves. (I leave out Mr. Buckland's, which is that the fish have to ascend a long distance before they deposit their ova. As the ova ripens inside the Salmon, more or

less pain is caused, which prompts it to seek at all hazards the first spawning-ground. It is for this reason that the fish whose ova are ripe now attempt to spawn in the Dowles Brook, and in the Cound Brook, and the lower part of the Teme,[1] for the reason that it proves too much, for if true fish would seek the first spawning-ground, and these streams are not the first the fish could enter). First the quality of the water, and the temperature of these tributaries. They have all the same character to some extent. Each is a mountain stream; the Teme rising in the Radnorshire hills, the Dowles Brook coming from the Clee Hills and Bewdley Forest, the Cound from the Church Stretton Hills; each comes from a limestone country, and the water of each is pure and of the same kind. I have not been able to get any information as to the temperature of the Dowles Brook or the Cound, but so far as in a very limited way I have been able to test it there is practically no difference between the temperature of the lower Teme and the Severn, but I am bound to admit my observations are most fragmentary; I hope, however, to get them more complete. I have also no record as to the comparative hardness of the different waters. If these were the *only* streams that came from the limestone, it would seem that this was the solution, but there are others which seem equally well adapted for Salmon which also come from the limestone, and

[1] Fourteenth Report, p. 37.

which Salmon do not frequent. This explanation is, therefore, not satisfactory. The other explanation is the hereditary one, that fish return to the places where they and the parents were bred. This was for a long time a very popular theory, especially of Mr. Buckland's, who used to put it, "I hope it is true, as most Salmon are bred in my kitchen;" and it used to be stated that Salmon invariably returned to the streams where they were hatched. And if these streams are regarded as the most suitable for Salmon, and that, therefore, as the supply of Salmon in the rivers fell off, the fish were only found in the streams most adapted to them, and the fish, being bred in those streams, returned to them and to them alone, it might be satisfactory. There are, however, great difficulties in the acceptance of this theory, for Salmon frequent certain streams to breed, and hardly ever are seen in those streams at other times.

In the Teme below Powick Weir and the Severn, a distance of about two miles, there were, in the winter of 1884-5, something like 100 beds, which would give about 200 fish. For the last ten years not more than twenty clean fish have been caught in that length of river in any one year. So if the hereditary theory is correct, the fish that are bred in the Teme never return as clean fish to the river, but only as breeders. Another instance is a Denbighshire stream, the Tanat. It is a prolific breeding stream, but clean fish hardly ever enter, but pass by its mouth and go further up the Verniew, into which it falls.

The same is the case with the Dowles Brook and the Cound. A clean fish has hardly ever been known to be taken in either, but every year fish spawn there. To show how fond the fish are of the Dowles Brook, it may be mentioned that over fifty have been counted in less than half a mile. In one week in December, 1872, the water-bailiff caught and put into the Severn forty fish from the Dowles Brook, and in a few hours the fish had all returned to the brook. Another argument against the hereditary theory is that in some years fish frequent one stream much more than others.

One of the best breeding streams in the Severn fishery district used to be one just mentioned, the Tanat. Soon after the Severn Board was formed, a fish-pass was placed in a weir at its mouth (Abertanat), and the river became a most prolific breeding stream. About 1881 the fish seemed to desert it for no apparent reason, and when it would have been expected that they would have frequented it more than ever; and the number of fish that now spawn there are much less than used to be the case, although the stock of fish that ascend the stream is larger.

If the hereditary theory was correct, the Tanat ought to be one of the most, if not the most, frequented of the breeding grounds of the Severn. It would have naturally been expected from another cause that during these years the Tanat would have had a larger stock of fish than ever. In 1880 the Liverpool Corporation obtained their Act for the

construction of a large reservoir at Llanwddyn, at the head of the Verniew. In the course of the work it became necessary to wash a large quantity of stones, gravel, and sand, causing much dirty water. The dirty water was allowed to go into the Verniew, and for some time formed a serious pollution. Very fine particles of mud were in suspension in the water, whereby it was much discoloured, and deposited a slimy sediment on the bottom of the stream. The Salmon that were caught in the upper Verniew were obviously affected by it. It would have been thought that the fish would have disliked the dirty water, and gone up the first clean river they reached, and so avoided it; but, strange to say, they decreased in the Tanat, and swam through the dirty water to the clean water of the Banw, another tributary above the pollution. So far as can be ascertained there was no pollution whatever in the water of the Tanat, and nothing to induce the fish to leave it. Why they did so is one of the questions the answer to which would throw some light on Salmon preservation. It is just possible, but most improbable, that the hereditary is the true explanation—that all the Tanat-bred fish, except those that returned there, had been caught or had perished—but the explanation will hardly hold good in the next case. Until 1881, from two causes, the Severn above Welchpool was, to a great extent, without Salmon. The first cause was the Poolquay Weir, which the fish could only ascend in the highest floods; for although there was a fish-

pass, that pass was practically useless. The second was that the lead mines, especially the Van, so poisoned the river above Welchpool as to render it unfit not only for fish but also for animal life. In 1881 the weir was washed away, and the effect of the low price of lead was to reduce the working of the mines to very small proportions. Salmon have increased considerably in that part of the Severn. They cannot have been bred there, for the quantity now seen would be in excess of anything like the proportion that would result if the fish had been all bred there. Where they come from, and how they have ascertained that the weir was washed away, are questions to which any answers would be most valuable, but the presence of Salmon seems to show that the hereditary theory is at least not of universal application. An explanation offers itself as to the time when fish ascend certain streams in a large river like the Severn. A fresh down one of its tributaries may cause a rise of the main river, and lead the fish to pass the mouth of those streams that were not affected by the particular rainfall. Thus, a heavy rain in Montgomeryshire might account for the fish passing the Teme and Dowles Brook, but that cannot be accepted as a complete explanation until the fact is ascertained if fish follow the fresh, and pass by the streams down which no fresh is descending. As far as my observations go at present, it does not seem that this is the case, at all events not universally.

Another point as to the distribution of spawning-fish is one of practical importance. In the present state of the English and Welsh rivers all of them are understocked, and there are miles of spawning-ground that are not used. In order to get the fish up to the spawning-ground, no pains are too great to get the best possible passes ; but is it desirable to pass fish over the weirs at the head of the river as long as there is plenty of unstocked spawning-ground below ? The doubt arises in this way: at the head of a stream of which the fish are fond, the gravel is turned over and over by successive arrivals of fish, and of course much spawn is lost. If no fish-pass existed in the weir, only that lot of fish who got over in the high water would be able to use it. Is it better to trust to those fish to stock the river, or let all go up there ? If it could be known for certain that the fish that were stopped would spawn in suitable places then it would be better to stop them, but, if not, it is a question that depends on the balance of convenience. It at least points to this, that Fishery Boards should have what they have not now, a power of stopping up and regulating fish-passes if they considered it desirable. Now any one, Fishery Boards included, who does any act that impedes a fish passing through a fish-pass is liable to a penalty. Boards have power to exclude altogether fish from a stream, but have no power to regulate the use of a stream by fish.

If Salmon are engaged in spawning, and a fresh

comes, do they continue spawning about the same place, or do they ascend with the fresh? On these points I have never been able to get any reliable information; the nearest approach to it was once when trying to catch Salmon for artificial propagation just above a weir. Several half-spawned fish were caught. Below the weir was a favourite place for Salmon to spawn, and there was no place where it was likely they would spawn above for two or three miles. Two days before the fish were caught, Salmon were seen spawning just below the weir, and the fresh was of such a height as to take fish easily over it. This, at first sight, seems to show that the fish left off spawning and ascended the stream; but it would be very unwise to draw any inference from a single case, especially as cases are met with where Salmon, driven off the beds by a rise in the water, have spawned at the side of the stream near the banks.

It is usually said that among spawning-fish the proportion of males to females is very large, but no very satisfactory evidence of this exists; and, if it is so, no explanation of the reason. The males are much more easily seen than the females; they fight and make a disturbance in the water, and show themselves more, and it is nearly always the males that are found dead after spawning; it is very rare to find females, but, so far as my observations go, the proportion of male to female spawning-fish is not so very much larger as is supposed. This is confirmed by the following figures, taken from the Usk. In

the winter of 1871–2, a water-bailiff was directed to ascertain the sex of all the dead fish he found. His return was :—January, 1872, 6 males, estimated weight 69 lb. ; 10 females, estimated weight 83 lb. ; February, 17 males, estimated weight 206 lb. ; 14 females, estimated weight 171 lb. ; total, 23 males, estimated weight 275 lb., 24 females, estimated weight 254 lb. Buckland says that the difference in numbers arises from the males being able to get up the weirs easier than the females. He argues the effect of weirs is to cause this preponderance. Two things confirm this. Among the clean fish taken, the proportion of males is not very greatly in excess of females ; and if the fish jumping at a weir are counted, although there are doubtless more males seen than females, for it is obvious that a fish heavy in spawn would run at the weir in preference to jumping, yet the number is not so much in excess as this appearance of the fish on the spawning-beds would lead one to expect. It may well be, that as the males are always swimming round the beds, while the females only come out of the deep water when they are actually about to spawn, the males appear to be the most numerous. That the males preponderate there is no doubt, but no satisfactory explanation has ever been given why they do, and the question is further complicated by the fact that in some seasons the number of males is larger than others. On the Usk, in 1870-1, the proportion of males to females exceeded four or five males for each female ; in 1871-2 it was about four or

five males to each female; in 1872-3 the number of males and females was about equal.

It is very difficult in any way to form any estimate of the quantity of ova deposited in a spawning-season, and the difference in this respect between a good and a bad spawning-season. At one time I endeavoured to have a list made of all spawning-beds that could be seen, but this was very unsatisfactory, as it was plain that a number of beds passed unnoticed. Of course, the number of beds is a most important fact to take into account; another, is the quantity of salmon seen at the weirs; another, the quantity of dead fish observed after spawning. By observing each run of fish at the weirs, the quantity seen in or near the spawning-beds, the number of beds, and the number of dead fish, a very rough estimate can be formed; it is by no means reliable, but it is the best that can be got. For the Severn district a good spawning-season would mean from about 2,000 to 2,500 pairs of fish spawning; taking the size of these fish at 10 lb. each. (From the Table of the size of the fish taken in the same district this is below the average, but I think that the large mesh lets through a large number of small-sized fish, and the average size of the fish that reach the spawning ground is lower than that of the fish that are caught). This would give, with 2,500 pair of fish, and roughly applying the rule as to the proportion of ova and weight, that each fish had 1,000 ova for each pound in weight (it is really 800 to 900),

25,000,000 ova for a good year; a bad year would not give more than 1,000 pair of fish, which, by the same rule, would give 10,000,000 ova. These figures are a little over the mark, and 850 should be substituted for 1,000 per pound. As the nearest approximation on the very scanty materials one has, the seed sown to produce the salmon harvest of the Severn, varies from 10 to 25,000,000 a year. In his 13th Report, Mr. Buckland makes this calculation as to the rate of fish that were lost to one river, the Caldew, by a flush in a week, by being unable to spawn. "200 fish attempt to spawn in the Caldew. We will suppose half of the fish to be females, carrying 1,000 eggs each to each pound of her weight. At the average of 10 lb. each fish they would have produced 1,000,000 eggs; deduct half for the eggs lost and destroyed, 500,000 eggs; deduct half again for fry killed, leaves 250,000; deduct half again for smolts killed, leaves 125,000; deduct half again for grilse, say, leaves 62,500; deduct half for accidents, leaves 31,250; average each Salmon at 5 lb. weight at 10d. per lb., and we find the approximate value of Salmon, at the lowest calculation, lost by the present state of this one mile and a quarter of the Caldew is no less than £6,510. 8s. 4d." This is a fair specimen of the way the value of our fisheries is officially arrived at. It is a beautiful instance of counting your chickens before they are hatched. If it is carried out it gives rather startling results. Thus, if £6,510 represents a mile and a quarter, £5,208 is the value of a mile; but the Severn has at least 153 miles

of spawning-ground always available; therefore, the spawning-ground of the Severn represents £796,824 a year; unfortunately, such a figure is purely imaginary: it might as well be called a million at once.

It is a still harder task to say what percentage of this ova is hatched out; this depends on the weather to a great extent. In a wet season much ova is deposited in unsuitable places, and on the river returning to its normal state, the greater part is either never hatched out, or, if hatched out, is lost. A dry season is also very detrimental; for as the fish come up and spawn when there is a slight rise in the water, as the water keeps sinking the beds are exposed, and the ova is either left high and dry, or only covered from time to time, and destroyed by birds or other enemies.

This year, 1885, much ova will be imperilled owing to the mills making the height of the river vary from time to time more than is usually the case, and for two or three days at a time leaving the beds high and dry. An interesting experiment as to this ought to be carried out. How long will ova that was left in a bed from which the water is often drawn off, but occasionally, as on Sundays, flows over it, retain its vitality? Fashionable as pisciculture has become of late years, it has mainly been devoted to the rearing of fish, and not to trying experiments such as this. Some such experiments would be most valuable, as they would enable some idea to be formed as to what quantity of ova perishes

in a dry season. A wet season produces just the converse case. The fish make beds in places that, while the winter level of the water remains, are well adapted for the purpose; but with the spring comes a fall in the water, and then either the ova is never hatched out, or, if hatched out, the little fish perish from the water drying up.

Another point to be considered is the relation between a good spawning-season and a good fishing-season. The idea seems to be prevalent that a good spawning-season means a good fishing-season three years hence. This is a very large assumption, and one that is not borne out by the Severn figures.

The following table shows the spawning-seasons on the Severn from 1866:—

1866–67. Good supply of fish, but river flooded.
1867–68. Smaller supply of fish, river very flooded.
1868–69. Fair; very favourable weather, but fewer fish.
1869–70. Good.
1870–71. Fair; fish arrived very late.
1871–72. Bad; fish very late in arriving.
1872–73. Good; fish arrived early and spawned early.
1873–74. Good; average season.
1874–75. Very bad.
1875–76. Very good.
1876–77. Moderate; constant high water.
1877–78. Fair average.
1878–79. Bad.

1879–80. Below average, but better than previous year.
1880–81. Very bad.
1881–82. Very good.
1882–83. Bad.
1883–84. Good.
1884–85. Very bad.

From this it would appear that the good years were 1869–70, 1872–73, 1875–76, 1881–82, 1883–84. If the fish caught in the three years following are taken, we get the result:—

1873. 10,000; a very bad year.
1876. 21,500; a good year.
1879. 9,500; the worst year but one recorded.
1884. 30,000; a very good year.

The results being, out of four good spawning-seasons only two good fishing-seasons follow at the distance of three years. If four years are taken we get the following result:—

1874. 16,500; an average year.
1877. 18,500; an average year.
1880. 16,000; an average year.

The worst spawning years were 1871–72, 1874–75, 1880–81, 1882–83.

Taking three years we get as the result of the fishing season:—

1875. 14,500; a bad year.
1878. 12,500; a bad year.
1884. 20,000; a good year.

Or, taking four years, we get :—

1876. 21,500 ; a very good year.
1879. 9,500 ; a very bad year.

It will be thus seen that it is impossible from a single spawning-season to give anything like a prediction of a good fishing-season. Of course, it must be admitted that a good spawning-season is an essential of a good fishing-season, but the mere fact that a good spawning-season will be followed after an interval by a good fishing-season is not borne out by the result. The table suggests another important point : how very few good spawning-seasons there are. Out of the eighteen recorded, only one-third, or six, are good ; seven average or moderate ; five bad. If the figures that have been previously given as to the quantity of ova deposited are referred to, it will be seen that it will not give a higher average than 15,000,000 or 16,000,000 a year. At the Exhibition of 1883, the American Fish Commission used to say that they thought nothing of annually artificially breeding double or treble the quantity. The amount is absurdly small ; there are at least 500 miles of spawning-ground in the Severn district ; of these there would be 250 miles accessible to Salmon, and this would give only 64,000 ova per mile, or, in other words, four pairs of 15 lb. fish, or a pair of fish to each quarter of a mile, a space in which at least twenty-five pairs could spawn. When once the fact is realised, the wonder is not that the Severn fisheries are not

more profitable, but how it is they produce so many Salmon. The great thing is to develop the supply of early-breeding fish at the best time and the most suitable place; but to do this it is necessary to try and find the answer to some of the questions stated above, and to find out, if possible, why it is that the Salmon will not resort to certain streams. Briefly stated, the problems of which some solution is wanted as to spawning-fish, and on which any notes or observations are desirable, are:—

1. Can any reason be assigned for Salmon frequenting particular streams to the exclusion of others (*a*) for breeding (*b*) in the spring and summer?

2. Do Salmon, ascending a river, follow the high water, or turn up the tributary, if no fresh is coming down it?

3. Do spawning-fish, if a fresh comes, leave off spawning and further ascend the river, or do they only remain near the place and spawn in quiet water?

4. How long will ova, deposited in a bed, survive if it is left high and dry for part of every twenty-four hours, and for how long can it be so left?

5. How soon do Salmon that come up in November and December begin spawning after their arrival at the spawning-grounds?

6. What are the earliest and latest dates of Salmon spawning?

7. Are the fish hatched from ova that is subjected to alteration in the quantity of water as strong and vigorous as those who have uniform supplies of water?

CHAPTER III.

KELTS.

WHEN the Salmon have spawned, the next point to ascertain is what becomes of them. The answer that is usually given is, that they drop down into the deep water, and remain quiet until the next flood, when they go down to the sea. It is by no means clear that this is the true explanation; that some fish go down early is certain, but, as there are clearly several groups of spawners, it is not easy to say at what period after spawning the Salmon begin to descend the river: those that go down in the spring floods may be those that spawned in October or November, and I incline to think that Salmon remain some little time after spawning before they migrate to the sea. It is true that kelts are often caught at different parts of the river in February, but, as it has been already said, it may well be that those are the early spawners. I have seen caught at the same draft, in the same net, a clean fish, a kelt, and fish about to spawn, and my impression is that the kelts wait some time before descending. Neither is it clear that they wait for a flood; they gradually drop down until they come to a weir, and probably if no weir interfered with them they would go on dropping down till they reached the salt water. It is one of

the many evils that weirs inflict on rivers that they detain and delay the fish on their downward progress as well as on their upward. Everything about Salmon, especially about kelts, is disputed, but no one disputes that it is desirable that the sooner the kelts are cleared out the better, for probably no more ravenous beast than an old kelt is to be found, and he is not particular what he takes. I believe that they fatten on samlets; at least, they will take a samlet greedily. I have tried the experiment frequently. If, fly-fishing in March, a samlet is caught and used as a bait with spinning-tackle, in a pool in which kelts are, it is almost a certainty to hook one. It may be that the samlet is so bright that he makes the most attractive spinning-bait that can be used; but, whatever it is, spin with a samlet in a pool in which there are kelts, in March, and the chances are a hundred to one you hook one—not that a kelt confines himself to spinning baits—he will take a fly, a worm, or almost anything. I have caught them with a live minnow, and once with a roach; in fact, as he is recovering from an illness, his appetite is good, and he is not particular how he satisfies it. The moral seems to be, get rid of him as soon as possible, and do all that in you lies to pass the kelts down the river. This is equally important as passing the breeding fish up the river; it may be even more so, yet the Legislature, while giving very large powers for enabling Boards of Conservators to pass up fish, have not recognised the necessity to pass them down, and have actually

thrown impediments in the way of doing so. So far as my observation goes, a kelt swims deep in the water, and hence would rarely descend a fish-pass; indeed, although I have seen numbers of fish ascend a fish-pass, I never saw one descend voluntarily—I say voluntarily, for I have seen them washed down, but I never saw a Salmon use a pass for descending the stream, although the Legislature is careful to provide that fish-passes shall have enough water to enable them to do so. As I have said, kelts swim deep, and usually tail first, and one often sees them either in front of flood-gates or in mill-ponds. If the sluices in the weir were lifted up on Sundays, most likely the kelts would pass down, but this is an offence under the Salmon Acts.[1] So the kelts have to remain until either a flood comes, and the sluices are opened, or until they pass under the mill-wheels and are killed. If it is desirable to get rid of the kelts as soon as possible, then some change should be made in the present law, which forbids this being done. While the kelts remain in the river, they feed largely. The question what they eat is one that has not been satisfactorily solved. As I have said, I believe they are not particular, and eat most things. No one can look at an old kelt's head and doubt that a fish with that development of teeth does not freely use them, unless he is a most wonderful exception to the rule that Nature makes all things for use. What does he

[1] 24 and 25 Vict., c. 109, sec. 26.

use them on? They will take any bait. I once saw a man, fishing with a dead gorge for pike, catch a kelt, and it is said to be no uncommon occurrence. I have heard of a kelt being caught on a trimmer set for pike and baited with a dead fish. Unfortunately, one cannot make a very close examination of a kelt's stomach and ascertain their diet, as kelts have to be returned to the water uninjured, and those that are found dead are generally unhealthy fish that have not the same appetite a good healthy old kelt would have.

It is of often said, and as often denied, that Salmon injure the trout; if they do, I think that one great cause of that injury is from the kelts; they must eat, and, if the river only contains trout and samlets, they perhaps are by no means particular which they eat. This gives rise to the question whether, after all, it is desirable to kill down the white fish in a Salmon river. Do not the roach and dace form food for the recovering kelts? Food they must have, and, if there are no white fish, the trout and samlets would suffer more than they otherwise do.

Except that kelts can be caught with a live bait, and sometimes with a dead bait, I have no evidence to show, although it is more than probable, that they eat white fish; and it would be a most desirable point in our knowledge of Salmon if it could be ascertained on what kelts chiefly feed; if they do eat to any extent the white fish, then the policy of exterminating the white fish that is carried on in some places with

such vigour is a mistake, as it is only increasing the destruction of the trout and samlets. If, on the other hand, they do not eat white fish, then it is clear that the white fish should be kept under in trout and Salmon rivers. Looked at in this light, the answer to the question on what do kelts feed, is the one that requires an answer as soon as possible, whatever it may be. At all events, kelts feed freely on something, and they reduce the stock of fish-food in the rivers; and, as they must go sooner or later to the sea, the sooner they go the better, as thereby less food is consumed. The question of the delay of the kelts in the river gives rise to another most important question. No one who has paid any attention to Salmon but is aware that every spring a number of kelts die of a disease that closely resembles, if it is not identical, with the well-known Salmon disease (*Saprolegnia ferax*). A short time after the spawning is over, by the side of the river, in shallow water, fish are seen sick, and dying, and dead, covered more or less with a white fungus. From what source it comes it is impossible to say, but three points with regard to it I have oftened noticed.

1. More male fish are found attacked with it than females; in one year, out of 143 diseased fish found dead, and examined, 136 were males.

2. In the majority of these male fish the milt, or a portion of it, is found indurated.

3. In severe winters far more diseased fish are found than in mild winters.

It is difficult, if not impossible, to give any satisfactory explanation of this, or the cause from which it arises; but two other facts may be noticed :—

1. That when Salmon disease has appeared in the Severn among the clean fish, it had appeared in the spring before the kelts were all cleared out.

2. That after a flood and the disappearance of the kelts the disease also disappeared.

The observations are too few and too scanty to admit of any deductions that are in any way reliable being made from them, but they would seem to point to this: that the disease was highly infectious, at least to fish newly arriving in water where diseased fish were—in fact, to fish that were not seasoned to it; that on the kelts being cleared out the source of infection was also cleared out, and the disease ceased.

Against this, which at first sight appears a plausible view, must be set the fact that an outbreak of disease occurred in the tidal part of the river where the water was salt, and where, so far as one could ascertain, there were no kelts. Of course it may be plausibly urged that as the stock of fish increases, and the feeding-grounds become more thronged, one may expect that if the disease arises from anything to do with spawning the disease would increase. In fact, when one begins to theorise on the subject there is no end to the theories, all sufficiently plausible, that may not be started. All that can now, with the very little, if any, knowledge one possesses, be said, is to state what facts have been observed, and

be careful not to say *post hoc* must necessarily be *propter hoc.*

One thing at least is clear, that, whether they lead to the disease or not, it is to the interests of the river to get rid of the kelts as soon as possible, so that they may return to the river marketable fish, and as they must go to the sea before this can be brought about the sooner they go the better. The bulk of the kelts go down in the spring, how long after spawning one cannot say, but as a rule the kelts are cleared out by the middle of May. In a fresh they may be seen going over the weir, usually tail first, but, as already said, I think they are always dropping down the river, generally singly; but when they get to a weir or an obstruction they wait for a fresh, and so form into small shoals. You may, if the water is clear and not too low, see several kelts in a pool one day, and two or three days after they are gone. One hears of kelts being taken in nets when there has been no fresh to take them down the river, and when the nearest spawning-ground is some distance above.

The bulk return to the sea at the end of March and during April. I say this from the fact that, when the fixed-engines fisheries were allowed to fish during the spring in the Severn estuary, at times in those months they used to catch large quantities of kelts in the putchers, especially if during those months there was much land water coming down the river. But this is not so conclusive as it might be, because the fixed engines were not usually used before the

middle of March, and therefore no evidence exists as to what quantity of kelts came down in February and the early part of March. The reason why it is said that the kelts go down in a flood, is because when there is a high water they may be seen passing over the weirs. I never felt quite sure whether they were washed down or went down of their own accord. They are certainly of their own will going seaward, but they are generally in a weak, sick state, and when they get into the strong stream at the head of a weir it may well be that they get carried over.

This is a point that observation would go some way to clear up, and any one who on a spring day stands at the head of a weir on the upper reaches of a Salmon river can generally see the loom of a kelt or kelts above the weir, and often see them carried over. At first sight this appears opposed to what I have said as to kelts swimming deep; but it is not really so, for at the head of nearly all the weirs there is a large quantity of backing, which goes at an angle more or less acute to the bed of the river, and if the mill is not at work the very force of the stream over the weir would draw the kelts to it; and, even if the mill was at work, the greater volume of stream passing over the weir would bring the fish that way.

The bulk of the kelts are gone by the end of April; some, however, remain, and these remaining fish are a very interesting Salmon problem. Do they ever go to the sea again, if so, when? if not, do they ever

spawn without going to the sea, or what becomes of them?

On every river in May, June, and even as late as July, well-mended kelts are found; fish that it requires some experience and knowledge of Salmon to tell when alive from new fish. They are quite as bright, often brighter than fresh-run Salmon; they are usually thin, as if they have not had enough to eat, but they are as active, if not more so, than any other Salmon. I am not at all clear if a well-mended kelt does not show far better sport than any other Salmon, and for this reason: a new fish fights harder at first, but does not keep it up as long; he is stronger but fatter; he is not in training and gets blown; and although game to the last has to give in sooner than a kelt; for the kelt is in good training, he has no fat about him, he has recovered without going to the sea, and is vigorous; accordingly he takes more time to kill, he is trained and active, and if he lacks anything it is strength alone. I never yet saw a kelt, however well-mended, whose flesh was the same colour as that of a clean new fish; and, although I have seen both the ova and milt of a well-mended kelt in a rudimentary state, I have never seen it in any way developed. I should add I have never had the opportunity of examining a kelt after July.

The case of well-mended kelts is one of the most interesting Salmon questions, for if a fish that stays all the year in fresh water will breed in the autumn, we get something like the question that

used to be so vigorously debated at the Fisheries Exhibition, as to the land-locked Salmon. All that one can say at present is, that kelts do remain until the summer. It may be they are only the late-spawning fish, but there they are, and why or wherefore it is as yet impossible to say. The presence of these kelts has given rise to some great difficulties in Salmon legislation. There are two terms often used in Salmon Acts, the definition of which has proved a difficulty. The terms are "unseasonable" and "unclean" Salmon. Unseasonable Salmon has been generally admitted to mean Salmon caught out of season, that is, during the close time in force on the particular river, but unclean Salmon cannot be so easily disposed of. Some most amusing definitions have been given, such as "all Salmon who have not been to the sea since they spawned;" "all Salmon that have not spawned;" "all Salmon about to spawn;" "all spent Salmon." I recollect the following definition being gravely put forward for insertion in an Act of Parliament. "Unclean Salmon are Salmon about to spawn; male Salmon with the milt, and female Salmon with the roe largely developed; male Salmon marked with orange and vermilion-coloured spots on the cheeks; male Salmon with lower part of the gills yellow and the under part black; male Salmon with the body tinted with gold and orange, and with black spots." This is very accurate as a partial description of an unclean Salmon, as far as it goes—there was a good

deal more of it. A member of a Select Committee of one of the Houses of the Legislature on the Salmon Acts, who had been a sailor, and to whose consideration the definition was submitted, read it as far as I have quoted it, and then remarked: "This wont do, I am —— if it is not longer than a stern chase." It is the fashion among many young legislators now to try their hand at drawing Acts of Parliament. Let any one who wants to do so try and produce a short, exhaustive, and accurate definition of an unclean Salmon.

When the kelts get to the estuary, then arises the greatest of all Salmon problems—what becomes of them? When this is solved, we shall be in a fair way to know something of the Salmon fisheries. Do the kelts go out to sea? Do they remain in the estuary? How long do they remain away before they again ascend the river? On these points our information is really *nil.* I incline to think they go out to sea, because they are so rarely met with in the estuary, and the fact that kelts are hardly ever taken in the fixed engines that fish on the flood tide leads me to that conclusion. If the fish remained wandering up and down the estuary, then they would sometimes be caught in the flood putchers as well as in the ebb ones, but this is very seldom the case; but the ebb putchers used to catch the kelts in great numbers, and *prima facie* the kelts caught in them would be the kelts descending the rivers, although they may be those that had come up the river with the flood and

drifted back on the ebb. The quantity taken used to be very large. One witness before the Inspectors (who was, however, not examined on oath) stated that in March and April the average weight of kelts caught in the putchers was twenty tons. As Mr. Buckland regretfully says, putting each fish at 10 lb. this would give no less than 4,480 fish returning to the sea killed in two months, after they had safely survived all the poaching and obstacles of the upper water.[1] I cannot help thinking these numbers are much too high, but if the kelts are in anything like these numbers, all that can be said is that at present we know next to nothing of the habits of the Salmon when they return to the estuary. They do occasionally wander about in the estuary. Once a fish that had been caught in the Wye, marked and returned, was a month after caught in a flood putcher on the Severn, some distance above the Wye mouth. This, however, might be accounted for by the fish reaching the estuary on the back of the ebb, and going up with the first flood tide. There was another instance, of a kelt caught with a fly in its mouth that a Wye angler identified as his: the kelt was caught some way up the estuary above the Wye mouth. But these examples are too weak even to construct a theory upon. We have yet to learn what becomes of kelts when they reach the estuary. As to the time of the migration of the kelts seawards, the following Table gives the

[1] Fourteenth Report, p. 46.

best information I have been able to get from observations in the Severn district:—

1866–67. Kelts were returning as early as January 7, 1867, and many until the end of March.
1867–68. Kelts were returning on January 12, 1868. Seen going down until March.
1868–69. February and March, April and May.
1869–70. Kelts migrated very early; most of them gone by middle of March.
1870–71. Very late; kelts hardly gone before May.
1871–72. Late; kelts descending till middle of April.
1872–73. Early; fish returned very early, and were mostly gone in early part of March.
1873–74. Very early; none seen after March.
1874–75. Very late; kelts were about until the end of May.
1875–76. Kelts left about the usual time, March and April.
1876–77. Very early; kelts migrated before end of March.
1877–78. About the usual time, March and April.
1878-79. Early; few kelts after March.
1879–80. Late; kelts continued till beginning of May.
1880–81. Early; kelts out by beginning of April.
1881–82. Early; March and April.
1882–83. Began very early, January and February; but kelts remained till middle or end of May.

1883–84. Early; most of the kelts gone by end of March.

1884–85. Late; did not begin to descend in any number till March.

The latest instance of a kelt I have heard of was in July, 1885. On July 29, a water-bailiff at Welshpool saw some men fishing with a bush-net for trout. They caught a Salmon, and his report of it is as follows: "It was a male kelt, very red and very thin, apparently about 15lb. weight, ought to have been 25lb. if in condition. The cartilaginous hook was still attached to the lower jaw, and the vent was very loose and open." From the description the fish must *have recently spawned*, for if it had spawned any time the vent would have closed and the fish become bright. I can give no explanation as to this. I have never heard of a fish spawning in July. Well-mended kelts have been taken in July, as in the Usk on July 24, 1871; but I have never heard of recently-spawned fish being taken in the end of July before this.

Some of the problems that require solution as to kelts are:—

1. What become of the fish after spawning?
2. How long do they remain before they begin to migrate seawards?
3. Do they migrate in shoals, like the ascending fish, or singly?
4. Do they wait for a fresh, or gradually drop down from time to time?

5. What do kelts eat while they remain in fresh water?

6. What is the reason why certain fish stay so long behind the others? What are the well-mended kelts?

7. Do the well-mended kelts go to the sea? If so, when?

8. Do they spawn without going to the sea?

9. What become of the kelts when they reach the estuary?

CHAPTER IV.

SMOLTS.

THE problems that surround the Salmon in his mature life are by no means confined to that stage of his existence. Even in the parr state, before the fish leaves the fresh water, and while he is, as it were, under the eye of the observer, he is a subject of great dispute. The time was—I am not sure that it has passed away—when it was gravely urged that a samlet was not the young of Salmon, and the Court of Queen's Bench decided that, although every one is bound to know the law, he is not bound to know facts, and that unless it could be proved that a man knew that samlets were the young of Salmon he could not be convicted of killing them.[1] As there are very few persons that would state with certainty that a particular fish was or was not a Salmon, the result of the decision would seem to legalise taking samlets to a very large extent. The different names by which the young of Salmon are known are enough to confuse any ordinary person, and when it is added that it is not illegal to take the young of the genus Salmo only of the Salmon species, the matter is still more complicated. The names given in the Salmon Fishery

[1] Hopton *v.* Thirlwall, 9 L. T. (N. S.) 327.

Act, 1861, are usually applied to the young of Salmon (*Salmo salar*) only. They are, "fry, samlet, smolt, smelt, skirling or skarling, parr, spawn, pink, last-spring, hepper, last brood gravelling, shed, scad, blue-fin, black-tip fingerling, brandling, brondling."

They relate, in some cases, to the time when the fish were hatched, in some cases to the appearance of the fish, and as to some it is difficult to give a definition, but all apply only to the young of the Salmon. The question has often been asked, What is an infallible guide whereby to distinguish a young Salmon from a young trout? A Government official was once foolish enough to give what he called one. An unfortunate fisherman was foolish enough to act upon it, and the result was, he was at once convicted of killing young Salmon. Like the case of an unclean Salmon, it is very hard to lay down any definition. It is easy enough to do so in ordinary cases, but there comes at times a fish that has the characteristics of both Salmon and trout, and the difficulty is to say what he is. I recollect once hearing a man tried for taking samlets. He was very well defended, and the solicitor asked the witness, who swore positively to the fish being a samlet, if he could always identify a samlet from a trout. To my horror, the witness said, "Yes." "Are you sure?" "Certain: I could not mistake." Four bottles were then produced, marked A, B, C, and D. In these were fish preserved in spirits. The witness was asked what was A? "Samlet." B? "Samlet."

C? "Trout." D? "Samlet." And he stuck to it: pointed out the distinctions to the Court. For the defence, a witness was called who had bred the fish, and placed them in the bottles. They were all four the same, and hybrids! I am bound to say I was very nearly falling into the trap myself, and should certainly have said that the fish were not the same, only I considered D was the trout, and the other three samlets. It is only, however, very rarely that these cases occur; usually any person who has had any experience can tell a samlet without any doubt.

About ninety days after the eggs are deposited, as a rule, the young Salmon are hatched out. I think that the time depends a good deal on temperature and on other causes; and one experiment that I am anxious to see tried is, how far the process of hatching-out can be accelerated or retarded by altering the condition of the ova. Of course, the experience of the exportation of the Salmon ova to New Zealand throws some light on this question; but the ova there is in an artificial state, and does not fulfil the conditions of an ordinary case, where ice, or dry weather, or some other cause, may alter the conditions under which the ova is placed. In most piscicultural establishments, the condition of the ova is uniform, or nearly so, throughout the whole time of hatching, and so they furnish no very satisfactory guide. What is required is to find out how long ova placed in a bed which is sometimes dry and sometimes frozen, sometimes covered with water of various degrees of

temperature, retains its vitality, and whether it will hatch out at all, and if so, under what circumstances. The difficulty of the experiment is, that by disturbing the bed the conditions may be altered. But it is a question of very great importance, as one of the elements of success in a spawning season is that the ova should be satisfactorily hatched out, and if in a river there are places where it is doubtful if the ova will or will not hatch, it may be well for the Conservators to consider whether Salmon should be allowed to go to such places; and, even assuming that the ova does hatch out, then comes the question, Do the altered conditions during the period of hatching make any difference on the fish hatched? Are they so strong and so vigorous as those hatched under uniform conditions? On being hatched out, the young fish usually remain in the gravel until the bag is absorbed; in the first three stages they are liable to various enemies. I have seen a large water-beetle catch them. How many he could eat, and what quantity he would take, I cannot say, but I expect that it would be considerable. I am by no means so clear that the water-ouzel takes the spawn so much as he does the fish in this stage, before they are fully developed. Very likely they are taken at both; and what I have not been clearly able to satisfy myself upon is this: the young fish attract the water-beetles (*Dyticus marginalis*), "the terrible, fierce beetle," as Buckland calls him; the ouzel feeds on the beetle. Which do they take from choice,

beetle or fish? They take both, but if they destroyed the beetle, they would be conferring a positive advantage on the fisheries; while, if they only took the young fish, it would be the other way. Ducks certainly swallow up the young fish; any one who has seen them poking their bills under the stones must be sure that they enjoy immature Salmon quite as much as any other animals. Eels also, I suspect, although I have no precise evidence of it, are very injurious to Salmon in this stage. Buckland's observations on the injury done by ducks at this stage of the Salmon life are worth reading. They will be found in the 14th Report, at p. 61. The young fish remain in this condition for about fifty days, when the bag disappears, and the fish become perfectly developed, and are then about an inch long. This would give from the time of spawning about 140 days for the development of the complete fish, and it would seem therefore, from this that the fish would be developed in something like the following order:—

Early spawned fish (October and November), end of March and beginning of April.

Second run of fish (Christmas and January), May.

Third run of fish (February), July.

This shows very clearly the importance of the early-spawning fish. The rivers keep up a fair height during March and April, and the fish, then fully developed, will be able to take advantage of the rise and fall of the water; but, if it is a dry summer, the fish developed in May run great risk of perishing for

lack of water, which the fish in July almost certainly do. It is very often thought that a good spawning-season is all that is required, but there is great danger of the whole being lost. I believe it is from this fact that persons are so often disappointed in the produce of Salmon fisheries. A splendid spawning-season is reported ; three years hence we shall (so it is said) have a large run of fish. But the fish don't come. The spawn may have been duly laid, but how is it hatched out ? This is never taken into account.

This year (1885) I have heard of fish spawning as late as the end of March ; and one year I heard of fish, full of spawn, being caught in April. On the Usk on the 12th of May, 1861, a fish was taken full of spawn. This would make it August or September before the young fish were developed. I believe that late spawning is much more usual than is generally supposed ; and I do so for this reason. When the water is low, in August and September, numbers of small fish, from one to two inches, may be found on the fords and in the pools ; these can only very recently have been fully developed, and would be the result of late spawning. The old notion used to be that the young Salmon were hatched out in March and April, and grew very rapidly, and the next year, in April and May, migrated to the sea. I think it is clear that this is an untenable theory. That a large quantity of samlets are fully developed in those months, and go down to the sea during the months of April and May, I fully admit, but I am, on the

present evidence, inclined to hold that there are, in a river fairly stocked with Salmon, smolts of various sizes and ages, and that the time when these fish migrate depends upon various conditions—that no hard-and-fast rule can be laid down.

The next point to be considered is the rate at which the young fish grow. Judging from the experience of pisciculture, the fish eat voraciously and grow rapidly, but I think it would be erroneous to reason from artificially-bred and fed fish, and that in this case much depends on the time of hatching. From April to October food would be plentiful, and the fish would thrive and grow rapidly ; but from October to March food would be scarce, and the fish would certainly not increase at the same rate. Here some reliable experiments are required. A fish hatched out in April would certainly be much stronger and bigger in October than one hatched out in June. As far as I know, I should say a samlet hatched in April would average about three inches in October. The samlet hatched out in June would not average above two inches in October. In the autumn, in the eel-nets, samlets, in at least three different stages, are almost always met with. 1. There is first the large samlet of from four to five inches, the fish that, presumably, will migrate in the floods next April and May. 2. The fish from three to four inches, that I take to be early-hatched samlets of the year ; and, lastly, the samlet of from one to two inches, with very highly-developed parr marks, which is the late-

hatched samlet of the year. Any night in September and October all these three kinds may be taken in an eel-trap. What becomes of them during the winter? Do they increase in size? I venture to think not; or, if they do, to but a limited extent, for, first, the stock of food must be very reduced, and, second, I have seen the three classes of samlets in February in much the same state as the three classes in October. A small-meshed net in February will often land some of each size. If I am right, the large samlets are those that migrate in April and May; their parr marks disappear about that time, and the silvery scale, that is, the mark of the migratory fish, appears. The second class feed and fatten during the season, and are ready to migrate when two years old; while the third either pass into the second class, or else must stay a longer time in the river. This brings up the question, how many migrations are there in the year? All are agreed that there is a spring migration—are there any more? I incline to think there are, and for two reasons: 1. It is generally admitted that, before migrating, samlets are given to congregate; and I have certainly observed this tendency to congregate in the autumn as well as in the spring. No one who has seen a shoal of samlets migrating seawards can mistake it; and I have several times seen in high water, in August, a shoal of samlets, but whether they are migrating or not it is impossible to say. 2. It is rather to be expected that there should be an

autumn migration ; the very early-hatched fish of the previous year, or the late-hatched fish of two years before, would then be ready to go ; whether they do or not is one of the problems that wait solution.

I have already stated what I saw in 1884, and perhaps other observers may have some evidence to give on the point. I think it may be taken that it is at least two years after they are hatched that samlets migrate seawards, but even this it would be desirable to prove as conclusively as possible. I again state that the rate of growth must be slower for fish that have to find their own living, than for fish fed artificially. During the two years that samlets remain in the fresh water the whole of their habits are worthy of close attention, and it is quite possible that from them some light may be thrown on the habits of Salmon. Samlets, before they reach the migratory stage, are solitary fish ; of course, a large number may be found in one pool, but they each act independently of the other. Unlike roach or perch, who always seem inclined to play at follow my leader, a samlet always takes an independent action. Drop a hook, baited with a worm, into a hole ; a roach smells it and rejects it—the others wont look at it ; but each samlet will go and smell it for himself. You may often see a samlet with a lot of other fish ; no matter what the others do, the samlet will act independently, and he always decides for himself the question if a bait is or is not eatable. So far as one can observe it, the same thing is seen in

adult Salmon ; if there are four or five in a pool, each seems to do what he thinks right, irrespective of the other. One has often seen several perch, pike, chub, and other fish, all come after a bait, but I never saw more than one Salmon do so at once. Another instance in which the samlet resembles the Salmon is the way he takes a fly. If you want to catch samlets, throw down stream and work your fly against the current, and you can fill your basket. Every one knows that a salmon-fly should be worked against the stream. Both to the young and to the adult fish, the fly drawn against the stream seems the most alluring way of placing the bait.

The voracity of young Salmon is marvellous; the quantity of worms they will take has to be tried before any one can believe it. I have, on a fine day, when the water is clear, looked down into a shallow pool where there were one or two samlets, and thrown in worm after worm ; the little fish will take them, shake them, and swallow them, as long as you feel inclined to throw them in. If the small fish are so voracious it is hard to see why the adult fish should, as some writers have said, spend his time in fresh water eating nothing.

It is impossible to give any idea of what proportion of samlets hatched out live to migrate to the sea. I am inclined to think only a very small proportion indeed. Everyone's hand is against them. Of the late-spawned fish, I have said how many must die from natural causes, from the water failing in the summer and

leaving the fish dry; but even if there is water enough left to keep the fish alive, they do not escape. Kingfishers, herons, crows, all frequent the shallow pools and feed on the smolts. The kingfishers are so few now that the quantity they take should not be grudged, but that quantity is not small. I one day watched a kingfisher for not quite an hour, and out of a small pool during that time he had six fish. I went and looked at the pool afterwards, and the only fish I could see were little samlets just hatched; if this was kept up the destruction would be considerable. I don't think herons take so many samlets as they do other fish; that they do take them I know, from having seen them, but herons are not so fond of the shallow places, where the samlets are generally found, as some other birds. The worst depredators are the carrion-crows. There is no more amusing sight than to watch an old crow descend on a sloping weir over which the water has just ceased to flow and pick up the little fish upon and near it. They seem to know the right state of the water and the right time to come. You never see them at any other time; but for an hour after the water has fallen below the level of the weir, if there is a carrion-crow in the neighbourhood he will be walking about the weir or near it, picking up what he can. They never seem satisfied, they leave no part of the ground unsearched, and leave nothing uneaten that they can get. The only bird that beats them is the gull, and a gull does all a crow does, but looks far

more impudent about it. I once shot a gull that had been poking about some pools near a weir for a short time after the water had been drawn off. It had not been there more than an hour, for I saw it come. I found, in a state to be counted, twenty-two small fish in his craw, and a lot of half-digested fish in his stomach. Imagine this done every day by a flock of gulls. I should be very sorry if any one considered that I advocated that either water-ouzels, kingfishers, herons, crows, and gulls, should be killed on account of the fish they take. I have no sympathy with killing down all birds and beasts that are supposed to do harm. It is the great mistake of so-called British sportsmanship. There is plenty for every one, and if the birds were destroyed we should no doubt find we had worse enemies than them to contend against; but, in determining the quantity of samlets that live to maturity, the depredations of birds must be taken into account.

It must, however, be remembered that the birds can do but little harm except in the summer and early autumn; if there is plenty of water, the crows and the gulls are unable to fish, and the kingfishers and herons cannot do very much mischief. The damage done by the birds might to a great extent be obviated if the stock of Salmon was kept up by early-spawning fish, for the stronger the smolts the deeper the water they frequent, and the less likely they are to fall victims to the birds.

But it seems only a passage from Scylla to

Charybdis; the fish in the deep waters are worse than the birds in the shallow water. Except roach, and dace, and grayling, I know few river fish that do not feed at times on young Salmon. Large chub are very fond of them. On a hot day a shoal of chub will lie basking on the top of the water, looking as if no fish were more lazy and innocent; all of a sudden they will start on a journey round the hole, and when they come to the place where the little stream there is trickles into the hole, the spot where the samlets are assembled in the cool water, the biggest chub makes a dash among the samlets, and one or more of the little fish are sucked down to those wonderful teeth a chub has in his stomach. Pike and trout revel in a meal of smolts, and it is no uncommon spectacle to see an old trout of 3 or 4 lb. chase the small fish about the hole; his ample digestive powers make frequent meals a necessity. Perch take another way; they watch the small fish go into the shallow water, and go for them as they come back into the deep. You can also see an old perch blockade a shallow pool full of fry, the water is too shallow for him to get after them, so he stays in the deep water outside; the fry endeavour to retire, and they see the perch, and go to the side of the shallow; he follows at last, keeping close to the side; they try to get out in a narrow file; the perch dashes in and catches what he can. Of course it is not all samlets that these fish take; all fry are the same to them, but they like Salmon fry, and feed upon it; and this goes on all

day, and every day, and must reduce considerably the number of fish.

But if they escape fish and birds there is man, and I am not sure that the fisherman is not often the worst of all the foes of the samlet. It is often said that catching samlets with a rod and line should be legalised, as no harm is thereby done; the quantity is imperceptible that would be so taken. This I think depends on where and when the fish are caught. In the summer and autumn, when the fish are not migrating, possibly the capture of a few samlets would be of no consequence; but in April and May, when the smolts are going seawards, then their capture is most destructive. The fish have survived all their enemies, and are at last on the journey to the sea to become Salmon; their capture then of course does the greatest harm it could do at any period, and unfortunately then they are most easily captured.

Good Friday is a great day on the Severn for samlet anglers; they come from the Black Country and elsewhere, and fish exclusively, though not nominally, for them. I one year met one of these men, and asked him what he considered a good day; he had six dozen samlets, and was grumbling at his luck; he said the best day he had ever had was just over twenty dozen, and if he got over ten dozen he was content. I did not believe such a thing to be possible, but I determined to try. On the Teme, a tributary of the Severn, in a distance of about a

quarter of a mile, in three hours, with a fly, I caught eight dozen and five, and I could have gone on catching as much longer as I liked. I am, therefore, inclined to believe that at the time of the smolt migration ten or twelve dozen a day can be caught with rod and line without difficulty. Multiply this by, say, 100 or 150 anglers, and give each a week, and it makes a large hole in a limited stock of fish. Buckland gives the following for the result:—"There are fifteen or sixteen smolts to the pound; a boy has killed 3 lb. of smolts, or forty-eight fish, in an hour, and in one day 13 lb. or about 208 fish; other anglers killed 25 lb. of smolts in an afternoon, or 1 cwt. a week; and it was a common thing to kill 11 lb. a day for several consecutive days."[1]

While there may be a good deal to be said as to allowing anglers to keep the samlets they catch accidentally when trout fishing, for I believe that few of them are returned to the water alive, yet I fear that if once the capture of samlets was legalised it would prove most detrimental to the Salmon fisheries.

What are worse even than anglers, are nets and traps. Although it is illegal to use traps at mills and weirs before the 24th of June, yet still a number are used, and numbers of samlets are caught every year; a heavy toll of the fish is taken as they go seawards. Again, there are nets used on purpose for taking samlets; a fine-meshed net dragged over the fords in April and May will generally yield a good

[1] Fifteenth Report, p. 17.

result. I am quite aware it is illegal, and that water-bailiffs ought to stop it; they do when they get the chance, but they don't often do this, and as long as there is a market for the fish, so long will they be caught. I have known of consignments of sixty and seventy dozen of samlets going from the Severn to Birmingham in a single night, and people wonder the Salmon fisheries do not increase.

If the fish survive all their enemies, they at last reach the sea. Before the statute 42 & 43 Vict. c. 26, numbers used to be caught in the putts, putchers, and fixed engines in the estuary; the slaughter has to some extent been put an end to by these engines not fishing before the 1st of May. The fish at last reach the sea; so far as we now know, nothing more is known of them. How long they stay, what they do, and when they return, are some of the problems we have to solve.

Buckland put forward a view of the great importance of smolts reaching the sea early, as they feed on the fry of the fish which in the spring of the year are hatched out in the estuaries in millions. "If the smolts arrive a month or six weeks behind their time, the sea-fish fry have either left or grown too large, therefore a late arrival in the sea means also short commons. This is especially applicable to the small fry; the large fish, however, feed principally on big worms, shrimps, and the fry of fish of a miscellaneous kind, ordinarily known as whitebait."[1] This

[1] Fourteenth Report, p. 64.

sounds so plausible that it should be true; but is there any very reliable evidence of it?

It is almost impossible to form any clear idea of the number of fish that reach the sea; after deducting the ova that does not hatch, the fish that from various causes do not reach maturity, and deducting from those that reach maturity those that are caught or killed, the remnant that is left becomes very small. I very much doubt if it makes 5 per cent.; at least I cannot, after making every allowance, bring it up to that figure; assume it does, that would give, on the assumption in the previous chapter, that the ova deposited in the Severn varied from 10,000,000 to 25,000,000 a year, a number of samlets varying from 500,000 to 1,250,000, a number that I believe to be in excess of the amount. What proportion of the number return it is impossible to say, but it is clear a very small part; the enemies of the fish are numerous in fresh water; in the sea their name is legion.

One of the great problems is how to avoid this waste of fish life. Artificial breeding seems to give one answer, but then it must be artificial breeding on a very large scale, and the establishment must be near the mouth of the river, so as to send the smolts at once into the sea, and to avoid all the dangers that beset them now, and the establishment must be large enough to permit of the smolts being kept until they are fit to go to sea. There are few, if any, of our Fishery Boards that could afford to keep up such an establishment, even if they are now legally em-

powered to do so. Another question arises as to the smolts; the object of the fishery legislation is to produce the largest possible amount of food, and it seems at present that this is not done. The great problem is how soon can the Salmon ova be turned into a marketable fish: is this done now as rapidly as possible? I think not. If I am right in the view I have put forward as to late-spawning fish, smolts are kept in the river at least half a year more than they need be.

Smolts hatched in July do not get as full a share of food as smolts hatched in March. Is it possible, by artificial breeding, to accelerate the migratory period of smolts? If it is, a great step in Salmon preservation will have been taken. If by keeping fish one year and feeding them artificially they will migrate in the spring of next year, while, if left in a natural state, they would not migrate until the year following, a great step will have been gained. Every day a smolt stays in the river he is in danger, and the object of Conservators should be to get him out of it as quickly as possible; if artificial breeding will do this, then it will prove a most important factor in the fisheries of the future, and, perhaps, solve the most important problem of all—in what time can smolts be artificially bred so as to be soonest ready to migrate seawards? Indeed, there is no limit to the importance of artificial breeding if it can accelerate the smolt stage. But artificial breeding of this kind does not mean merely hatching so many fry and throwing them into the

river; it means an establishment on a very large scale, in the nature of Stormontfield, a place where the fish are bred and kept, and not allowed to enter the river until they are migrating. Unfortunately I know of no English or Welsh Board that can afford to keep up such an establishment; yet if it could be done, and successfully done, it would do more for the Salmon fisheries than anything else.

The times of the spring migration of smolts, so far as I can ascertain them, for some years past, have been on the Severn as follows:—

1867. Early; March and April.
1868. April and May.
1869. Very early; February and March.
1870. April and May.
1871. Very irregular; some early in March, some in June.
1872. April and May.
1873. April and May.
1874. March.
1875. March, April, and May.
1876. Early; March and April.
1877. Very early; February and March.
1878. Early; March and April.
1879. Early; March.
1880. Late; April, May, and June.
1881. April and May.
1882. April and May.
1883. Late; April, May, and June.

1884. Early ; March and April.
1885. April and May.

It is interesting to observe the experiences of the smolts that were sent from the Usk to the Brighton Aquarium. These are fully stated in Mr. Lee's report, which is given at length in the Appendix ;[1] but I venture to doubt the conclusion he draws, or if anything is proved, for the experience of a smolt in captivity under abnormal conditions does not, unless confirmed by observations of fish in their natural state, prove anything. It raises a presumption that the things are as seen, but that is all.

The chief problems as to smolts are :—

1. How far can the hatching of ova be accelerated or retarded by variation in the quantity of water in which the ova is deposited ?

2. How long will ova live that is left dry during some hours on certain days, and what length of time can it be so kept ?

3. Is there any difference as to the time of hatching out the ova that has been so left ? How long does ova that has been deposited and left dry from time to time retain its vitality ?

4. Is there any, and, if so, what difference, in the state of the fry if the ova has been regularly immersed, or if there has been variation as to the immersions ? Are the fry hatched out from ova in a normal state stronger ?

[1] Page 203.

5. What is the difference in growth of fry hatched in March, May, and July?

6. Can the growth of the parr be accelerated or retarded by increase or decrease of food, and, if so, to what extent?

7. How many different broods of parr are there generally in the river at the same time?

8. How many migrations of smolts are there in a year?

CHAPTER V.

GRILSE.

FROM the time the smolt passes to the sea, nothing is really known about him. For a long time persons used to urge—I believe there are some who still urge—that the smolt is not the young of the Salmon at all, but a distinct fish ; that Salmon spawn in salt water. I once met with a publication, by an old Gloucestershire fisherman, to prove that Salmon spawned in the sea. What else did they go to sea for ? It would not be for amusement, they had lots of that in the river ; it could not be for food, they had plenty of that in the estuary : it must be to spawn. I am by no means clear that the argument was not quite as good as many that are used in fishery matters. What the smolt goes to sea for is still a question, as is where he goes, and what he does ; what he seems to do is to eat and to return to the river, but beyond this we know absolutely nothing reliable. The first question is, how long do the smolts remain in the sea before they return ? And this raises the question, in what state do they usually return ? Of course, it will be said as grilse. I am not quite sure that is universally true. Most likely the majority of smolts return as grilse ; but

fish are sometimes met with that are to all appearance Salmon, except as to size: the scales are not grilse scales, and the fish do not resemble grilse. What are these fish? they run small, hardly ever exceeding 5 lb. I can give no answer to the question, except they are not the same as grilse. They are specimens of *Salmo salar* in some stage of its development, but in what stage it is difficult to say; the experience of the Usk would seem to suggest that these fish may be hybrids. Any fisherman will state that he often catches small Salmon that are not grilse, but what they are he cannot tell you. The usual idea that grilse, or botchers as they are called in the Severn and the rivers that run into the Bristol Channel, are the smolts as they first return from the sea; but I have never yet met with any one who could give a rational account of what a small Salmon was. I am using the term Salmon as opposed to grilse. The only possible explanation I can offer is this: that as the mesh of net for Salmon is now universally so large that a fish of 4 lb. will easily go through it, a smolt that has not grown to the ordinary grilse size on its first return to the river has escaped capture from its size, has returned to the sea, and, still not growing, has returned a second time as a Salmon. This is most unsatisfactory, but it is the only explanation I can offer as to what are small Salmon. Of course, it may be that they are Salmon who have not returned to the fresh water at the proper time; indeed, it is quite possible

to start a number of theories as to them, as to everything else, but the question as to what small Salmon really are is still an unsolved problem. The next question, also an unsolved problem, is, where do the smolts go when they go to sea? Do they go far out or remain in shore, and, if far out, where? One is tempted to say at once they go far out to sea, for the obvious reason that the shore fishermen seldom catch Salmon when fishing for other fish. At times they catch a large number, but it is only when the fish are coming in that such capture takes place. The boats in Carmarthen Bay frequently in the season catch clean Salmon coming in shore, but I believe it is very rare for boats to catch unclean fish going out to sea. On the Tyne the hang-nets are fished at some distance out at sea, sometimes as far out as thirty miles. It is in the early part of the year they are worked furthest out. This is really a question on which nothing certain is known, for the fact of a stray fish being picked up now and then really proves next to nothing. We have yet to master the problem,—where is the home of the Salmon?

Wherever it is that the smolts go, the next question is, how long do they stay? It is usually answered: a year, or even less; that is, that the smolts who go down one spring will return as grilse certainly the next year, possibly before. There is really no evidence to show this is correct, and judging from the previous growth of the fish, it seems

very likely it is not. At the lowest computation it has taken a smolt a year, more likely two, to reach the size of six inches, and that under favourable circumstances as to food and water and climate. Why should he, in the second year of his life, grow three or four times as much as in his first year, and increase from ounces to pounds. It may be so, but it is so contrary to what one would expect that one requires some strong evidence to make us feel sure it is so.

The late Mr. Ashworth states:—"At three days old a young Salmon is nearly two grains in weight; at sixteen months old he has increased to two ounces, or 450 times his first weight; at twenty months old, after the smolt has been a few months in the sea, it becomes a grilse of 8½ lb., having increased sixty-eight times in three or four months. At 2¾ years old it becomes a Salmon of 12 to 15 lb. weight, after which its increased rate of growth has not been ascertained, but, by the time it becomes 30 lb. in weight, it has increased 115,200 times the weight it was at first."

With the exception of the multiplication, one feels inclined to doubt the above statement, or, at least, to ask for the evidence on which it is based. Yet no one did more than Mr. Ashworth to bring about the present Salmon Acts, and they were mainly passed on such statements as these.

The smolt, says Mr. Buckland, remains in the sea "a certain time." On this we are all agreed. It is a very different thing to say, as he goes on to say,

"some remain a few months, some a year; they then begin to return to the river as grilse." That they go, and that they return, is certain; the duration of time that they remain is uncertain, and to ascertain that time as near as may be is one of the many Salmon problems. However long they stay, the grilse usually return to the Severn in two batches, one—a small one—at the end of April and May, and the other from the end of June till August. Whether these returns correspond in any way to the periods at which they came to the sea, or whether the latter period is only the one at which they seek the river to spawn, irrespective of when they came to the sea, there is no means of ascertaining. The great fact is, that the bulk of the grilse do not come before the summer, and that later in the autumn the run of grilse disappears. Having regard to the fact that the bulk of the smolts migrate in April and May, it would seem that there was some connexion between the two migrations, but what the connexion is we do not at present know, nor do we know what interval takes place between the one and the other.

With regard to the run of grilse, some very curious points arise. The summer run of grilse used always to be looked forward to by fishermen as forming the most profitable part of the Salmon harvest, but for some years past there has not been, or, at least, fishermen say there has not been, the regular summer run there used to be, and various attempts have been made, all equally unsatisfactory, to explain it.

The following table shows the run of grilse on the Severn :—

1867.	Very small.	1876.	Moderate.
1868.	Very small indeed.	1877.	Moderate.
1869.	Good.	1878.	Bad.
1870.	Very small.	1879.	Bad.
1871.	Very small.	1880.	Bad.
1872.	Very small.	1881.	Very good.
1873.	Good.	1882.	Bad.
1874.	Moderate.	1883.	Good.
1875.	Small.	1884.	Moderate.

It will be seen, out of the eighteen years here recorded, the run of grilse is in only four years good, and that a good year is generally followed by a moderate, then by a bad year, and this seems borne out by the table as to the whole take of Salmon.[1]

It always seems to me that it is misleading, for the reasons already given, to take a good spawning-season as the necessary precursor of a good fishing-season. The fair thing is to take the number of smolts that descend to the sea. As nearly as I can give it, the following table shows the spawning-seasons, the smolts that reached the sea, and the grilse season :—

	Spawning.	Smolts.	Grilse.
1867.	Good.	Good.	Very small.
1868.	Fair, but less.	Very large.	Very small indeed.

[1] See page 136.

	Spawning.	Smolts.	Grilse.
1869.	Moderate.	Moderate.	Good.
1870.	Good.	Small.	Very small.
1871.	Moderate.	Small.	Very small.
1872.	Bad.	Small.	Very small.
1873.	Good.	Very good.	Good.
1874.	Very bad.	Bad.	Moderate.
1875.	Very good.	Good.	Small.
1876.	Moderate.	Very good.	Moderate.
1877.	Moderate.	Good.	Moderate.
1878.	Bad.	Moderate.	Bad.
1879.	Moderate.	Good.	Bad.
1880.	Very bad.	Very good.	Bad.
1881.	Very good.	Moderate.	Very good.
1882.	Bad.	Bad.	Bad.
1883.	Good.	Good.	Good.
1884.	Very bad.	Moderate.	Moderate.

From this it seems almost hopeless to trace any connexion, although there certainly must be some, between the smolt and the grilse. The fact that the supply of smolts was good in 1867, and very large in 1868, would seem to account for the good run of grilse in 1869. But then follow three bad years of smolts—1869-72—and a good year of grilse—1873; a very good year of smolts in 1873 is followed by a moderate year of grilse in 1874. Three good years of smolts—1875, 1876, 1877—are followed by six bad years of grilse—1875-80. The two good years of smolts—1879 and 1880—precede the abundant year of grilse—1881. There has been no very

good year of smolts since, but two good grilse years. It is, therefore, on our present information, not possible to say that a good migration of smolts will produce next year, or the year after, a good year of grilse; while still less can it be said that a good spawning-season will either in two, three, or four years produce a good grilse year. The fact is, that what are the conditions of a good grilse year are as yet unknown, but the evidence goes to show that the duration of the smolts in the sea is either very much longer than is usually supposed, or that the grilse, when they return to the river, do not return in shoals, or that the fact of their returning in shoals is due to some exceptional cause, only occurring at intervals of which we are unaware. I regret that I cannot get any information on this point from any rivers in other parts of England, for it is hardly right to argue from the experience of one group of rivers alone; yet the fact remains that all over England the fishermen complain that the run of grilse is not what it used to be. Fishermen always talk in this way, and I am tempted to doubt if, after all, the run of grilse before 1866 was really so regular or so large as it is often represented to be. The evidence on this point is by no means conclusive or convincing, resting upon the complaints of fishermen that they do not catch all they used to catch, and before the new legislation they caught far more fish than they have since.

In the report of the Inspectors of Fisheries for 1876, Mr. Buckland mentions the matter, and gives as the reason the increase of drainage in the country.

"The reason[1] must be general, as the summer migration of the grilse seems to be altered, and altering, all over the country. The one general change that has taken place is, without doubt, drainage. In previous reports I have given examples of floods running down quickly under circumstances where, in former years, many weeks were required for the flood to clear itself off. I am not at present in a position to state the exact manner in which the alteration of land-drainage has affected the summer run of grilse, but that the alteration in the character of the floods has much to do with the alteration of the run of grilse, I feel convinced. It is also a curious coincidence that a land-drainage Act came into existence in 1861, simultaneously with the Salmon Fishery Act. Alterations in the drainage over large tracts of country have taken place under this Act both in England and Scotland. It follows, therefore, that the supplies of water to the rivers having been altered since 1861—fifteen years ago—the conditions of floods in the rivers would also be affected. I have reason to believe, therefore, that the cause of the run of grilse being affected is by the alteration in the system of drainage. I have great hopes during the ensuing summer of being able to determine, with some degree of accuracy, the bearing of one set of facts on the other."

I have quoted this at length, as it gives a fair specimen of the way in which our fisheries are

[1] Fifteenth Report, p. 19.

managed. Instead of those who have the control endeavouring, by means of scientific investigation, to ascertain what are the causes that produce a large run of grilse, whether normal or abnormal, it is assumed that the run of grilse has altered,—a fact that has yet to be proved,—and then the land-drainage is resorted to as an adequate explanation. Tenterden Steeple and Goodwin Sands at once recur to the mind. Land-drainage may have had some effect on the rivers, but what that effect is has yet to be proved. The Land-Drainage Act, 1861, has been resorted to in comparatively few instances, and the fact of the successive wet seasons that we have had since this was written will go far to show that it was not land-drainage that affected the rivers. The best commentary upon it is, that the next year after it was written was a good year of grilse! Buckland also says, "the only solution I can suggest is, on account of the scarcity of food, or some other physical cause, the smolts descending to the sea during the year 1870 do not come back to the river as grilse in 1870 at all, but they must remain in the sea until the spring or summer of 1871. I fancy this to be more often the case than is generally suspected, for it seems contrary to the general law of the multiplication of animals that a smolt should descend from the river to the sea, and come back in a few months as a breeding fish."[1] Although I incline to agree with Mr. Buckland, I must point out that this is all inference: there is no evidence to support it.

[1] Fourteenth Report, p. 65.

It is, however, a much easier task to demolish the theories of other persons than to give a right explanation as to grilse. The real difficulty is not that they do not constantly appear every year at the same time, but why do they appear at all in shoals on certain occasions. It is very easy to say that, as the smolts get down to the sea at different dates, so the survivors return at different dates; returning one by one, not in great shoals, their appearance is not noted. It is only in particular years, when a large shoal comes at once, that the movement of the grilse is noticed; and the problem seems to be, not why do not the grilse every year come in large shoals, but what causes them to run sometimes in large shoals and not at others. Every year a certain quantity of grilse are taken through the season, the chief time being in the late spring and the summer, but only in some years is there a large run. If the Severn tables prove anything, they only show that there is little if any connexion between the run of smolts and the run of grilse, and that an extraordinary year of grilse is exceptional, and not the rule. There is absolutely no reliable evidence to prove what causes the exception; the problem that waits solution is what causes a good run of grilse. The Tweed figures on this point are interesting. From 1808 to 1853, in no year were less than three grilse taken for each Salmon; from 1853 to 1876, only two grilse were taken for each Salmon. Thus the Tweed figures show that grilse have fallen off. Another and most interesting point occurs here, which will be more fully discussed in a

subsequent chapter,—What leads the grilse to seek the river at the time they do? Of course, every one will answer, to spawn; but neither the ova nor the milt of the grilse are so developed that they require to come at that time to spawn; and probably, if none of them were caught, they would not spawn for at least another three months. What, then, do they come for? Why do they quit the sea before the time when they want to spawn? There is some cause that we have yet to discover that will give an answer to this question. The question also arises whether all the grilse that ascend the river stay and spawn. Of course some do, but it is by no means clear that all do. If any one has watched Salmon, either on the beds or jumping at the weirs, he will have noticed how very small the proportion of grilse is to that of Salmon. It will be at once said, this must be so, as there are far more Salmon than grilse in the rivers, and that is doubtless true to some extent; but the number of grilse, so far as one can see, that spawn are below the proper proportion. I can only state this as a fact: I know of no evidence that shows that grilse return from the rivers to the sea without spawning; but still, so far as one can observe, the number of grilse that spawn is not so large as would be expected. Grilse being light, strong, and active fish, and running early in the summer, one would expect to find the fish at the upper parts of the watershed to consist mainly of grilse; but this certainly is not the case, not even in a wet summer, when there is a good run. It often

happens that on the Severn one hears of a good run of grilse in the estuary, and as far up as Gloucester and Tewkesbury, but it is very rare to hear of anything like a run above Worcester. It will be said that they are all caught before they get there, or cannot get up for the weirs, both which reasons are, to some extent, true; but still the fact of the very small, almost infinitesimal, number taken, especially when compared with the number of Salmon, leaves something to be learned.

It may be said that this is an instance of the wonderful economy of Nature that, as a Salmon would carry so many more eggs than a grilse, it is therefore so much better to have adult Salmon than grilse in the upper waters. This is doubtless true, but it does not explain why the heavy fish which would not be so active and so able to pass over obstacles are more often found in the upper waters than the light, active fish, that are more adapted for passing up. I can give no answer to any of these questions, and only hope that persons will by observation try to clear up the life of a grilse in fresh water.

Another point worthy of notice is whether the grilse return all the year round, or only at stated times. I have already said that in the Severn in the months of February and March it is rare to take grilse. Does this point to the duration of time the smolt remains in the sea? At first it would appear to do so, but it is far from uncommon to find smolts descending to the sea in March, and instances are not

wanting of their doing so in February. One would therefore expect to meet with grilse in both those months, but it is very unusual to do so. The explanation as to this may lie in the temperature, for grilse do not, as a rule, run before the warm weather; still it is one of the facts to be taken into account. So far as I know, grilse do not run after October. Of course, there are stray grilse that may be taken at almost any time in the year; but from September to April it is exceptional to meet with them. If there is an autumn migration of smolts, there should be an autumn run of grilse; if grilse resort to the river to breed, there should be an autumn run of grilse; but as a rule there is not; and it may be broadly stated that, so far as we know, the bulk of the smolts migrate in the spring; the bulk of the grilse return in the summer, and that it is only the full-developed Salmon that return to the river in autumn and winter. As already stated, it may be a special interposition of Providence that only the fish that will produce the most should ascend at the breeding season; but this is hardly a satisfactory explanation.

There are two causes that may have had some influence on the habits of the grilse. I have not evidence enough to give any opinion if they have, but it is worth considering them. First, in 1861 a uniform mesh of net two inches from knot to knot was made compulsory. Whether that was right or wrong is too large a question to discuss now, but it has remained the mesh on the Severn for Salmon

ever since. Before that date a much smaller mesh, 5½ inches round the square, was used. No doubt the large mesh allows a number of fish, that would formerly have been caught, to escape, and by this means numbers of grilse pass unobserved. I have no direct evidence as to grilse, but I have as to sea-trout. If you ask a Severn fisherman if they catch sea-trout he would tell you "hardly ever"; and, of course, it is very seldom, or hardly ever, a sea-trout would be caught in a net with a mesh of eight inches round. But if a small-mesh net is used in the tributaries of the lower Severn in the autumn you are almost sure to catch some sea-trout, and they have decidedly been increasing of late years. As to the habits of sea-trout in the Severn, nothing whatever is known. As I have said, their existence would be denied; but there they are, and it is by no means improbable that the effect of the large mesh may be the same as to grilse as to sea-trout; and the reason why so few are caught, or so little is heard of them, is that they escape through the net; and so one of the facts in the solution of several important questions as to Salmon becomes neglected. If this is so when a two-inch mesh is used, it is still more likely to be the case when a two and a-half or three-inch mesh is used. And it may be that the disappearance of the grilse may be connected with the use of a uniform or large mesh. The other cause is the uniform close time. When the close times varied over the greater part of England and Wales, and on some rivers there were even different close times on dif-

ferent parts, one of the results was that in some places fish were always being taken. Now, however, there is, or at least there should be, an absolute cessation of fishing for five months in the year. During that time, except in the tideway, in the upper waters on the fords, and at the weirs, and, occasionally, leaping in the pools, there is no opportunity for observing the habits of fish. We know nothing of what takes place during close time ; whether there is an autumn run of grilse, and whether they go in any numbers : all is a blank. It is quite right that this should be so, in the interests of the fisheries ; but it is impossible to find out very much as to the habits of a fish as to which, during at least half a year, no information is available. Many of the difficulties that now seem to beset the question would probably be cleared away if more perfect observations were made as to the habits of the fish throughout the year. I hope it will not be thought that I am saying a word against either the mesh of the net or uniform close time. I should be the last person to do so. I only mention these as two causes that may have something to do with the explanation of what is now unexplained.

In the Report for 1876,[1] Buckland gave the following table as the information he collected in 1868 as to the run of grilse in the English and Welsh rivers :—

Lune	July.
Ribble	10th to 15th July.
Dee	At all times.

[1] Page 20.

Clwyd and Elwy	End of August and September.
Seiont	August, September, and October.
Usk	July and August.
Wye	July.
Severn	June, July, and August.
Taw and Torridge	All the summer.
Avon and Erme	July and August.
Dart...	August.
Trent	Beginning of July.
Tees...	Beginning of August.

More precise information would be very desirable. The return, "at all times," on the Dee, is not very definite, and the Seiont return for October showing an autumn run is remarkable.

From the Usk reports one or two very interesting facts as to grilse may be gathered :—

1. The average weight of the grilse, taken since 1868.

Year.	lb.	Year.	lb.
1868	4·50	1877	5·49
1869	4·79	1878	4·94
1870	5·04	1879	—
1871	5·40	1880	5·60
1872	5·53	1881	5·23
1873	5·95	1882	5·08
1874	5·19	1883	6·03
1875	5·01	1884	5·16
1876	5·68		

It will thus be seen that up to 1873 the average weight of the grilse steadily increased ; it then decreased for two years, and for the next years it varies.

It is difficult to give any explanation of the steady increase up to 1873, and of the subsequent variations.

2. The proportion of grilse to Salmon taken. It would be expected that the proportion of grilse would be larger than the proportion of Salmon, for Salmon have had to pass through the grilse stage and survive its dangers; but the figures are certainly surprising :—

	July. Per cent.	August. Per cent.	Sept. Per cent.	Oct. Per cent.	Total. Per cent.
1869 ...	54				
1870 ...	40	60			
1871 ...	50[1]	62	61	50½	48
1872 ...	43	53			
1873 ...	70	76			

It will be seen from this what a very large percentage of grilse are taken in the summer months on the Usk; in August half the takes are always grilse, and it would seem that protection increases the percentage of grilse. The variation in size of grilse is well shown in the year 1873: two of 11 lb. and one of 10 lb., exceptionally large ones, and one of 1 lb., an exceptionally small one, were taken.

3. A third point as to grilse: the time when the male and female fish run, and their respective sizes, are well brought out by the following table. The late grilse are said to be larger than the early grilse. This is only what might have been expected, if it is the fact that the late ones have remained longer in the sea than the early ones, but it is impossible to ascertain this, or do more than state the fact.

[1] Rod fish.

THE USK TABLE AS TO WEIGHT OF GRILSE:—

	June.			July.			August.			Total.		
	Males.	Females.	Monthly Average.	Males.	Females.	Monthly Average.	Males.	Females.	Monthly Average.	Males.	Females.	Total.
1868 ...	...	...	...	...	...	4·50	...	...	...	...	...	4·50
1869 ...	...	...	...	4·96	4·37	4·79	...	...	...	4·96	4·37	4·79
1870 ...	...	...	6·33	...	...	4·81	...	...	5·08	...	...	5·04
1871 ...	...	...	4·50	...	...	...	...	...	5·40	...	...	5·40
1872 ...	...	...	...	5·90	5·27	5·31	5·64	5·53	5·57	5·65	5·48	5·53
1873 ...	5·75	...	5·87	5·78	5·53	5·57	6·17	5·99	6·05	6·12	5·87	5·95
1874 ...	5·50	...	5·50	5·12	5·06	5·06	5·56	5·03	5.21	5·54	5·03	5·19
1875 ...	...	5·00	5·00	4·66	5·08	5·02	5·27	4·93	5·01	5·15	4·97	5·01
1876 ...	4·00	5·50	5·25	5·98	5·58	5·69	5·92	5·54	5·69	5·92	5·59	5·68
1877 ...	...	4·75	4·75	6·62	5·17	5·29	5·89	5·46	5·60	5·96	5·34	5·49
1878 ...	...	...	...	5·21	4·77	4·83	5·08	5·25	5·23	5·18	4·91	4·94
1879 ...	...	...	...	...	...	...	...	...	...	...	...	...
1880 ...	...	...	...	...	...	...	6·26	5·40	5·60	6·26	5·40	5·60
1881 ...	...	...	...	...	5·38	5·38	5·84	5·06	5·18	5·84	5·16	5·23
1882 ...	...	...	...	...	...	...	5·64	5·05	5·08	5·64	5·05	5·08
1883 ...	...	7·00	7·00	5·70	5·57	5·58	6·28	6·08	6·12	6·23	5·98	6.03
1884 ...	...	...	...	6·02	5·02	5·15	5·40	5·00	5·16	5·46	5·01	5·16
Average of 16 years.	5·25	5·63	5.64	5·58	5·22	5·21	5·92	5·53	5·59	5·87	5·46	5·51

The sex not having been in every instance recorded during the first year or two of the observations, the total averages are drawn from a somewhat larger number of fish than those of the males and females.

Taking the sixteen years average, it will be seen that while the late grilse are said to be heavier than the early grilse, that is,—the September and October grilse heavier than the June,—the June grilse are heavier than either the July or August. But in June the female fish are heavier than the males, while in July and August the males are heavier than the females.

4. A fourth point is that although on the Usk there are occcasional bad seasons of grilse, there is not such a decrease of grilse, and such a number of bad grilse years, as is noticed on other rivers. In 1875 there was a bad year both on the Usk and the Severn, but as a rule there is no line to be traced between the bad grilse years of the Severn and those of the Usk.

5. The per-centage of the male to female fish among the grilse is as follows :—

	July.	August.
1872	19 ...	34[1]
1873	18 ...	33
1874	10 ...	33
1875	— ...	—
1876	28·57 ...	38·06
1877	12·25 ...	31·45
1878	4·61 ...	11·76
Average of 10 years	18·73 ...	33·79

[1] The preponderance during this year was said to be very exceptional ; one gentleman stated that out of twenty-nine fish taken between September 11 and October 12, twenty-one were males.

It is difficult to suggest any satisfactory explanation of the great difference in the proportion of males to females among the grilse in August to what there is in July. The same thing, to a lesser extent, is observable in Salmon; there the ten years percentage is in July 18·2, August 29.04.[1] Why it should exist at all, or why it should be greater among grilse than among Salmon, is one of the points that has to be cleared up. It would be very interesting to know if on other rivers anything like the same proportion of males to females is observed.

The more important questions as to grilse are :—

1. How long do smolts remain in the sea before they return as grilse?
2. Do smolts always return to the river as grilse; if so, what are the small Salmon that are often taken?
3. Where do smolts go when they leave the river?
4. What is the explanation of there being in certain years very large runs of grilse at particular times?
5. What time of the year are the grilse most abundant in each river?
6. Is there any, and if so, what connexion that has been accurately observed between the spawning seasons, smolts and grilse?
7. What are the conditions of a good grilse year?

[1] See *post*, p. 155.

8. Can any explanation be given why the proportion of grilse that are observed spawning is so small?
9. When do the grilse return to the sea, and in what condition?
10. Can any reason be assigned for the run of grilse being largest in the late spring and summer?

CHAPTER VI.

GILLINGS.

IF difficult questions arise as to grilse, still more difficult arise as to the Salmon in his next stage. On the Severn in this stage the fish is locally called a gilling, and I have retained the name for want of a better. The answer that would be locally given to the question, "What is a gilling?" would be, "A Salmon on his second return to the river from the sea." Roughly, a botcher, or grilse, would be a fish up to 8 lb., from that to 15 lb. would be a gilling, and this would include all fish of that size. But although perhaps, broadly speaking, the definition may be correct, there are certain difficulties it fails to clear up. It leaves out of account all the small Salmon mentioned in the last chapter, and it makes weight the only test by which the age of Salmon is known. Doubtless weight is a valuable and important test, but it is not, and ought not to be, the only one. A fisherman will tell you that he always knows a gilling. If you ask him how, he will be rather puzzled to define it, yet there is no doubt if a botcher, a gilling, and a Salmon are all placed side by side, any person would observe that there was a distinction between them. It is not easy to be

defined; it is more in the shape and appearance of the fish. It would not be quite easy to say how you would define the difference between a boy of 17 and a man of 22, beyond saying that the one was immature, and the other more matured; and it is this difference, that it is impossible to place into words, that one would feel existed between a Salmon and a gilling. The Salmon is the mature fish, the gilling the immature. With regard to gillings some very interesting points arise; or rather, the same points as to the smolts and grilse present themselves under different forms, and become more complicated. We know something of the time and state at which the smolt goes to the sea, but as to the grilse we know next to nothing. The popular idea, and it may be the right one, is that grilse go down in the spring when the other Salmon that have spawned descend, but one cannot learn anything else as to them. They re-ascend in the early part of the year; the fish that are taken in February and March being mostly gillings. Indeed, the first part of the season is the time when the gilling harvest is looked for. All through the season some gillings are caught, but the largest number at the commencement of the year. There is also an autumnal run, beginning in August and extending into October, "Michaelmas gillings," but it is difficult to give any very clear information as to them, from the close time intervening at the end of August.

If a grilse goes to the sea, as is popularly supposed,

in the spring, how long does it take to turn him into a gilling? Looking at the fact that the run of gillings is in the spring of the year, one would be led to conclude that the fish that come down one year as grilse went up again the next as gillings. The difference in size would not be so great as in the case of smolts and grilse, for the grilse, as to size, would have to increase from 50 to 100 per cent. to become a gilling, whilst the smolt increases 500 to 600 per cent. to become a grilse. So that a shorter time might be spent by the fish on his second visit to the sea to what he spent on his first, and, being a bigger fish, and more easily able to take a larger supply of food, he might increase faster. The difficulty is not knowing accurately when the grilse goes to the sea, and in what condition he goes; if he has not spawned, probably he would increase much faster than if he had, as he would not have to recover and get into condition. Before anything can be clearly established as to the Salmon in its third stage, the question of the grilse must be worked out. The spring is the time the gillings chiefly return; they are ascending the stream as the kelts are descending, and it often happens that at the same haul of the net both kelts and gillings are caught. By a process of selection it seems to follow that as there are fewer grilse than smolts, so there are fewer gillings than grilse, fewer Salmon than gillings, and this the Usk figures as to the proportion between grilse and Salmon, quoted in the last chapter, seem to establish. The gillings, it would

seem, may be taken to represent the last stage at which, so far as we now know, the fish can be traced, having passed through the successive stages of fry, smolt, and grilse, and at each becoming less numerous. There are really existing no grounds upon which anything like a calculation can be based as to what proportion of fish reach the gilling stage; but as the proportion of smolts that reach the grilse stage is so small, and as in addition to all the enemies the smolt has to contend with, the grilse has also to contend with the fact that his capture is legal and meritorious, the per-centage that survive the grilse state and reach the next must be very small indeed, probably not over 1 per cent.

As it is difficult to find any connexion between the number of smolts that go down to the sea and the grilse that return, it is still more difficult to find any connexion between the smolts, the grilse, and the gillings. The following table shows the run of gillings on the Severn as nearly as can be ascertained :—

	Gillings.	Grilse.	Smolts.	Spawning.
1867.	Bad.	Bad.	Good.	Good.
1868.	Good.	Very bad.	Very good.	Moderate, but less.
1869.	Bad.	Good.	Moderate.	Moderate.
1870.	Very good.	Very bad.	Bad.	Good.
1871.	Moderate.	Very bad.	Bad.	Moderate.
1872.	Bad.	Very bad.	Bad.	Bad.
1873.	Bad.	Good.	Very good.	Good.

	Gillings.	Grilse.	Smolts.	Spawning.
1874.	Moderate.	Moderate.	Bad.	Very bad.
1875.	Very bad.	Bad.	Good.	Very good.
1876.	Moderate.	Moderate.	Very good.	Moderate.
1877.	Good.	Moderate.	Good.	Moderate.
1878.	Good.	Bad.	Moderate.	Bad.
1879.	Moderate	Bad.	Good.	Moderate.
1880.	Bad.	Bad.	Very good.	Very bad.
1881.	Bad.	Very good.	Moderate.	Very good.
1882.	Good.	Bad.	Bad.	Bad.
1883.	Good.	Good.	Good	Good.
1884.	Good.	Moderate.	Moderate.	Very bad.

It will be seen that it by no means happens that a good grilse year is followed at any fixed interval by a good gilling year, or that a good smolt year has any real connexion with either a good supply of grilse or gillings ; each seem to vary in a most unaccountable way. It is obvious that there should be some connexion between all these, and there can be no doubt if the connexion could be accurately traced it would greatly tend to increase our knowledge of the history of the Salmon. As has been already stated, gillings run chiefly in the spring, while grilse select the warmer months. There is nothing to show why it is so, beyond the fact that the gillings and grilse appear at those times ; nor can it be said that the approach of the Salmon to maturity causes him to seek a different temperature of water to what he did in his immature state. As will be shown more fully in the next

chapter, the adult Salmon are found in the rivers all the year round, and it may be that the temperature that suits the adult fish is not adapted to the immature. One knows so little that it is most dangerous to theorise, or suggest explanations. All one can say is, there must be some cause that makes the gilling a spring and autumn fish; what is the cause is a problem to be solved. In some respects, a good run of gillings is the most valuable of all the migrations of the Salmon, as, the river being full of water, and the gillings strong, active fish, they are, as a rule, easily able to surmount the various obstacles; and coming at a time of the year when there is usually but little fishing, they form the main stock of fish that reach the upper waters. Every angler knows the difference in the sport between a spring and an autumn-run fish. A gilling is generally in the height of condition, and by far the best fish both for sport and for eating that is met with in the course of the year. In large rivers, especially if they are much obstructed by weirs, if it were not for the gillings, no clean fish would reach the upper waters at all, therefore the upper proprietors and sportsmen should feel more than usually interested in this class of fish. On the Severn it may be said that of the whole quantity of fish that reach the upper waters in the open time by far the largest number are gillings. In January, February, and March, the fish have usually an opportunity of running up the stream, and it often happens in a dry year, as was the case in 1884, that

from April till October it would be impossible for fish to get up at all; if, therefore, there was to be a failure of gillings the upper country would get no clean fish. I have said they are the most active fish. This is shown, to some extent, by the fact that very large fish seldom get much beyond the tideway. Whether they are too heavy to travel, whether their size makes them inactive, I don't know; but the table on page 113, of the big Salmon of the Severn, shows that, with a very few exceptions, all the large fish are caught before the fresh-water weirs are reached. It is only in the spawning-season that the really big fish seem to care to pass on up to the head of the river. Another important view in which the gilling has to be regarded is the commercial. As being the fish that are caught in the first two months of the season, they command by far the highest price in the market. It is true of late years the price has fallen from what it used to be, and it is only just at the opening of the season that the retail price of 5s. or 4s. 6d. per lb. is asked; yet, of the gillings that are caught in the fresh water, far more fetch over than under 2s. per lb., and it is this price that makes such profit as is made on Salmon.

The subject of gillings also is intimately connected with the question of close-time. If it is true that the gilling is the fish that is more likely than any other to reach the upper waters, and that all the conditions for its doing so are much more favourable than those of any other class of

fish, should not the gillings have a free run to the upper waters? The upper proprietor, of course, replies yes; but the fisherman at the head of the tideway replies no, with equal vehemence, saying that the gilling is the most profitable part of the season's fishing. The conflict between the angler and the netsman cannot be better put than it would be over this class of fish. The point that it gives rise to is the important one, do not our rivers open too soon? There can be no doubt of this, that if the close-time was made to last till March 1, throughout England and Wales, the upper proprietors would get far more fish, and, probably, if it is the object of the legislature to give them more fish, nothing could be done by legislation that would better effect the object, and it would also have the advantage that it would interfere less with the general fishing throughout the district than anything else. In February there is little, if any, fishing in the estuary. The fish that are caught are caught by the draft-nets at the head of the tideway, and in the lower reaches of the fresh water. The persons who take these fish are, as a rule, simply takers of fish. They do nothing and they contribute nothing to the support of the river or the preservation of the fish, beyond paying the licence duty, which a good week's fishing at once returns to them. They would suffer a pecuniary loss, so that the upper proprietor might have a gain. It might be said that this would be unfair,—it would be only robbing Peter to pay Paul; but it is by no means clear that the whole

district would not benefit by the extension of the close-time. As has already been said, the great thing to secure a successful breeding-season is to get the fish up early, and it would often be a wise precaution to get the fish up in February and March, with a view to the coming spawning-season.[1] It will be said that this is looking a long way forward, but the fact that the fish cannot always get up must be taken into consideration. If the fish have to wait till the autumn, a dry summer and autumn may happen, and it may be physically impossible to get the fish up in time for them to spawn at the best advantage.

By closing February and March, one is tolerably sure that a certain supply of fish will be found at the spawning-grounds in the early autumn, and, if the importance of early spawning is admitted, this ought to overweigh any other consideration. But, unfortunately, the net-men reply, and with a show of reason, "If it is important to get the fish up to the upper waters, when they are there they must not be caught. It would be very well to forbid fishing in the spring, so as to let the fish get up for the good of the river, but how is the good of the river promoted if fish, when they reach the upper waters, are to be netted and killed? We might just as well take them

[1] In his last (24th) report, p. 28, Mr. Huxley denies this view, saying that there is no evidence that the fish which ascend early will breed earlier than those that ascend late. I can only say the whole of the experience of the Severn supports the view I have mentioned.

as the upper men. It is downright robbery taking the fish from us for others to kill, especially as the fish are in better condition for food when they are caught in or at the head of the tideway than elsewhere." An argument like this, although a purely selfish one, is difficult to answer. The usual answer is that the upper proprietors breed the fish, and are entitled to some return for this. This is answered by saying, the fish breed themselves, the upper proprietors only let them alone, and, if they touched them, they would break the law. This is true, but human nature is the same all the world over; and, if one sees a large fish that can be caught, it is, as I know, difficult to refrain from catching him. I was once coming back from shooting in Wales, and I saw some men at a river trying to gaff a Salmon in the pool. I could not help staying to look, and, as I stayed and saw the fish missed, I could not help thinking that I could do better; and thinking led to trying, and I never was prouder than when I hooked out the fish that professional Welsh poachers had failed to catch. I did not awake to what I had done until one of the men, who felt spiteful at my success, said: "And he calls himself the Chairman of a Fishery Board. I should like to know where he learned, and where he practises gaffing!" If the Salmon are to go to the upper waters at all, the owners must be allowed to take them. They would do it in some way, and it would only make the fishery laws more unpopular than they are now if it was not allowed. I shall be

told that Fishery Boards can now, by bye-law, extend the close-time. It is true that they can, but any such bye-law would most likely give rise to considerable difficulties; and if it was opposed, as it would be, it is very doubtful if it would be carried. That burlesque on a judicial proceeding—an inquiry before an Inspector of Fisheries—would be held, when all the stories, true or false, that fishermen are pleased to tell the Inspectors are taken down as evidence, and on the basis of them a report is framed. It is impossible for the Fishery Board to pass a bye-law if they are called on to prove that any positive good will ensue; it is, of course, a mere experiment, but an experiment that would be justified on our present knowledge of the habits of fish; yet it is extremely doubtful if such a bye-law would be confirmed, and the only effect would be that all the ill-feelings between the upper and lower proprietors on the Board would be excited, and no good done. It is just one of those subjects that can only be dealt with by legislation; and if upper proprietors desire to do themselves good, and the river good at the same time, when the next Fishery Bill comes before Parliament they will get the annual close season extended—at least, for the month of February. If this were done, another question would arise: Would the conditions of the river be altered thereby? If the bulk of the fish spawned before Christmas, what effect would that have on the migration of smolts, on the return of the grilse, and on the gillings? Might

not the periods at which the fish now return be changed thereby, and in ten or twelve years' time a new set of conditions exist in the river? This is, of course, one of the problems that have to be solved, and it is quite possible that it might alter things very materially; but the chance of this only shows the necessity there is for scientific investigation into the habits of Salmon; for if the times of the return of the fish can be altered by altering the existing conditions, then, of course, it is the great duty of those interested in the fisheries to find out what set of conditions will give the most beneficial results to the fisheries. The question is,—how can one produce the most Salmon? and, until all the different conditions under which Salmon can be produced have been fully tried and tested, it is impossible to say which is the best.

We have only tried one set of things, and it is by no means clear that that is the best that could be tried; indeed, our fisheries do not prosper in such a way as to warrant the belief it is even a good one. I again regret to say that the views I am here advocating are strongly opposed to those expressed by Mr. Huxley in his last report,[1] where he says he cannot discover any good ground for the belief that any kind of human interference is competent to affect the earliness or the lateness of a river; but, unless one knows what steps Mr. Huxley has taken to come to this conclusion, we may be pardoned for not accepting it.

[1] Twenty-fourth Report, p. 29.

With regard to gillings, the questions are:—

1. How long do grilse remain in the sea before they return as gillings?

2. Can any cause be assigned why the gillings mainly run in the spring and autumn?

3. How many runs of gillings are there in a year?

4. What is the age of a gilling?

5. Is there any, and, if so, what connexion, between the run of smolt, grilse, and gilling?

6. When do the gillings return to the sea?

7. Would any, if so what, effect be produced on the spawning-season in a river by allowing a free run of gillings to the upper waters in the spring months?

CHAPTER VII.

SALMON.

ON its third and subsequent returns from the sea, the name Salmon is applied by fishermen on the Severn to *Salmo salar*. While it is true the name Salmon properly includes the fish in all its stages, and nine out of ten people would call both grilse and gilling Salmon, a Severn fisherman, speaking of Salmon, would use the term to distinguish the one fish from the other, just as he would the terms jack and pike. On its third return from the sea, the fish is supposed to have arrived at maturity. It probably goes on growing and increasing in size until it attains to the weight of those monsters we sometimes hear of, but we know nothing of this, nor whether the fish increases in size after each visit to the sea, or even how often it visits the sea.

As has been said with regard to grilse and gillings, size is no criterion as to whether a fish is a Salmon in the technical sense or not. Very small Salmon are often met with, and, in the course of a season, Salmon varying from 5 lb. to 50 lb. may be caught. Beyond saying that some are large and

some are small, it is as difficult to give any reason for these varieties in size as it is to give any reason for the different sizes in other animals. The only thing that there seems any evidence of is, that, as a rule, the larger the river the larger the Salmon it produces. Salmon over 20 lb. are quite common on the Severn; those over 30 lb. are not rare; while on the Usk anything over 30 lb. is exceptional. On the small Welsh rivers a Salmon over 20 lb. is almost rare, and the average size of the fish runs much smaller. From the subsequent Tables it will be seen that the average weight for the last five years of Severn Salmon has been 12·03 lb. The Usk average, leaving out grilse, is 12·55 lb., so that the whole Severn average of grilse, gilling, and Salmon, is nearly the same as the Usk average of Salmon alone. With both rivers flowing into the same estuary, it is hard to see why this should be so.

Another point as to size is that the average weight of the fish would seem to have been increased by preservation. When, as was formerly the case, the kelts were killed off after spawning, the chances of mature fish escaping were less than now. Every one's hand was against a big fish; every one desired to kill him; he was not so active, and was more easily gaffed or speared than the smaller and more active fish. I am here distinctly at issue with Mr. Buckland. He says that big kelts, after spawning, do not so readily succumb to disease, which usually kills them. My experience is all the

other way: the fish that generally die after spawning are the large males. I could give numerous examples from the Severn; thus, in 1867, it was reported that "a large number of old kelts, nearly all males, some about 30 lb., were found dead; in 1868, a number of large dead male kelts, one over 4 ft. in length, were found dead; in 1870 a number of large dead male kelts were found." The testimony would be a repetition for nearly every year. From some cause that is not explained, the fish that usually die after spawning are mature males. Fewer large fish now fall victims to the gaff and spear than formerly, as large fish are less easy both to conceal and dispose of than small ones, but certainly more die. The only possible explanation that can be given is that the fish die of exhaustion; that the large males spend their time in fighting as well as spawning, and the combined effects of love and war produce this great mortality. But this is opposed to the other view, that the fish die from indurated milt, as these large males do more spawning than any of the others.

To what size will a Salmon grow? The largest recorded specimen of a Salmon in British waters is, I believe, the one of 83 lb. that was caught in a net in 1821. Mr. Buckland gives the following as his list of big Salmon, and he had exceptional opportunities of acquiring information, as the London fishmongers, for some years before his death, when they had a very big fish, used to send him word. His list is as follows:—

		Weight lb.	Length ft.	in.
1.	Tay	70	4	5
2.	Rhine ...	69	4	8
3.	Shannon ...	54	–	–
4.	Tay	53	4	0
5.	Rhine ...	51½	4	3
6.	Tay	51	4	3
7.	Wye	50	4	2
8.	Tay	49¾	4	0
9.	Shannon ...	46	4	3
10.	Wye	44	3	10½
11.	Tay	42	3	8

He adds that in August, 1879, there were, in London, six Salmon weighing 325 lb.; a Tay fish, 65 lb., measuring 4 ft. 5¾ in. in length, and 2 ft. 1¾ in. in girth; another 61½ lb., and four weighing respectively 53 lb., 56 lb., 49 lb., 46 lb.

Considering that these fish come from not only all parts of the United Kingdom, but also from the Rhine, I think that the Severn record of big fish in the last eighteen years is very satisfactory. In each year but one (1882) fish of 40 lb. have been caught; there were often many nearly 40 lb., but no record has been kept of fish under that weight. The following is the table:—

	lb.	
1867.	50.	
1868.	53.	Several between 40 lb. and 55 lb.

	lb.	
1869.	40.	
1870.	41.	
1871.	42.	A kelt of 35 lb., found dead.
1872.	52.	Caught in a stop-net at Gatcomb; 50 lb. on the Count Rocks, Severn.
1873.	64.	Caught in a putcher in Folly Weir, Littleton; one of 52lb. at Newnham.
1874.	56.	Lave-net, Lydney.
1875.	42.	Draft-net, Tewkesbury.
1876.	40.	A kelt estimated at over 40 lb., also found dead.
1877.	42.	
1878.	50.	Caught 18th March, draft-net, Lydney, Gloucestershire.
1879.	47.	Caught in a draft-net at Longney.
1880.	40.	
1881.	52.	Draft-net, at Bollow, Gloucestershire.
1882.	39.	Several fish over 30 lb.
1883.	47.	Draft-net, at Minsterworth.
1884.	50.	In a stop-net; one of 40 lb. in a draft-net at Powick, Worcestershire.

It will be seen that almost all the large fish are caught in the lower waters, and most of them in the tideway. For some reason, although the large breeding fish seem to get up to the head of the river, yet it seems quite the exception for a large clean fish to do so. The largest recorded fish caught on the Severn was the one caught in 1873, that weighed

64 lb., and measured 4 ft. 7 in. in length, and girthed 29 inches. He seems from Buckland's Table, given above, to have been rather long, as the 70 lb. fish was two inches shorter. It would be interesting to know the girth of the 70 lb. fish ; that of the Severn fish was tremendous. A man who saw him described him to me as being "as thick round the waist as our farm-girl." The Tay fish of 65 lb. was only 25¾ in. girth. From the foregoing Table it will be seen that a clean Salmon over 40 lb. runs about 12 lb. or 13 lb. to a foot, and this may be taken as a fair rule to judge the weight of large fish. It does not hold true in smaller ones. It is often said that a kelt, if in condition, would have weighed something enormous, but, trying them by the above rule as to length, it rarely happens one meets with a kelt over from 40 lb. to 45 lb. I can only recall three instances, one of a kelt that measured, or was said to have measured, 4 ft. 11 in. or 5 feet (I did not measure him myself), that was found dead at Powick in 1871. He was a male fish, and very much diseased, and when I saw it after it had been out of the water some days it was difficult to form any opinion as to its weight. Another was a kelt also, found in the Teme, that I did not see, but that the water bailiff measured, and reported to be one foot longer than his stick ; his stick was 3 ft. 6 in. The last was a large kelt found dead on the Tanat. It was said to be nearly 5 feet long.

The Table of Salmon caught in the public waters of

the Hampshire rivers, Avon and Stour, as given by Mr. Buckland,[1] are as follows; it is interesting as beginning *before* 1861.

Year.	Number of Fish.	Average Weight in lb.
1860. ...	... 40	
1861. ...	... 70	
1862. ...	... 80	
1863. ...	... 360	
1864. ...	... 380	
1865. ...	... 430 ...	... 14
1866. ...	... 460 ...	... 11¾
1867. ...	... 317 ...	... 12¼
1868. ...	... 75 ...	... 9½
1869. ...	... 652 ...	... 9½
1870. ...	... 873 ...	... 12¾
1871. ...	... 549 ...	... 12¾
1872. ...	... 364 ...	... 12
1873. ...	... 344 ...	... 12

This Table shows what results in weight and number of fish the efforts of the Board effected. It is added that in 1871 there were many heavy fish taken both in the estuary and in the river. In the estuary a 38 lb. fish; in the Sopley portion of the river one of 40 lb.; several fish in the water averaging 30 lb.; and in the year 1872 several heavy fish were caught with the rod at Ringwood; and a fish 36½ lb. taken in the estuary.

The Usk table of big Salmon is as follows:—

[1] Thirteenth Report, p. 20.

1782. A fish of 69 lb. taken with a small-mesh net.
About 1859. A 47 lb. fish taken at Newport Bridge.
1868. July 27th, a 31 lb. hen Salmon, very heavy in spawn.
1869.
1870. 36 lb., taken in Breconshire with rod and line.
1871. 30 lb.
1872. Several exceeding 30 lb.
1873. 44 lb., killed by the screw of a steamer, December 25th; 51 lb. kelt found dead.
1874. November 11, a bull-trout of 28½ lb., taken in the Usk district; a bull-trout of 30 lb. taken in the Goldcliff putcher.
1875.
1876.
1877. 33 lb.; one other over 30 lb.
1878. A kelt of 35 lb., measured 4 ft. 5 in. in length.
1879.
1880.
1881.
1882.
1883.
1884.

But while these seem small by the side of the Severn, it must be borne in mind that the majority of the fish caught on the Usk are rod fish; that there is no information as to the take of fish in the fixed engines in the lower waters of the Usk, where, if the Severn experience is to be trusted, the big fish would be taken. So that really little reliance for compari-

son can be placed on so incomplete a record. It does, however, show two very large kelts and an enormous bull-trout. If the Usk cannot boast the largest fish, it can boast of the smallest; it is recorded that a grilse of 1 lb. was taken in July, 1873, in a putt. This is only one ounce more than the smallest specimen of *Salmo salar* that has been recorded as having returned from the sea, the one of 15 oz. mentioned by Yarrell, which is preserved in the British Museum. The monster Salmon are said to be the result of a careful preservation of kelts, and their rarity seems to arise from the fact that the dangers that meet the Salmon are so numerous that it is very rarely a Salmon reaches old age. It is a very difficult question to say what age a 40 lb. Salmon is, or how often he has been to the sea. Buckland puts his Tay fish as between ten or fifteen years old, but gives no reason for this conclusion. He mentions in his 14th report[1] that Mr. Mostyn Owen, who was then the Honorary Secretary to the Dee Board, had told him of the capture of a marked Salmon. From this, and reference to the books, it appears that the Salmon was 7 lb. or 8 lb. when marked; it had been loose 7 years, and in this time had grown to 26 lb. This does not show a rapid growth in mature Salmon. Buckland adds: "Of course, it was not known how often the fish had been up and down the river." All that can really be said of a 40 lb. Salmon is, that at

[1] Page 65.

least it must be an eight years old fish, probably more. It must have been two years old when it descended to the sea as a smolt, probably another before it returned as a grilse, another before it became a gilling, and another before it became a Salmon; then comes the question, did it return to the sea as a Salmon and come back a still larger fish? This is a point on which we have absolutely no evidence as to how often a full-grown Salmon will go to the sea and return to the river, and what will be its state when it does so return. Indeed, on the age of Salmon the evidence is most meagre, and it is doubtful how long Salmon live, or when they reach their full development. The majority of Salmon (meaning the fish on its third return from the sea) would be taken on that third return, and would be fish weighing from 12 lb. to 20 lb.; those that returned a fourth time to the sea would be most exceptional instances out of a given number of ova,—the per-centage must be very small indeed. Still, to have survived and performed another migration is a lot reserved to few Salmon, and it is these few that are the monster fish we sometimes hear of.

We have really no evidence as to how large a Salmon will grow, or how long he will live, and how often he will return from fresh to salt water, and *vice versâ*. One thing is clear—that a full-grown Salmon puts on flesh at an extraordinary rate; a large kelt will increase in size and weight in a most wonderful

manner. On the 17th March, 1875, a 9 lb. kelt was caught with a fly in the Wye, between Hereford and Hay, and was returned to the river marked with a label through the dead fin; a Salmon with the same label was caught on the 24th August, 1875, in good condition, at Awre, in a putcher some twelve or fifteen miles up the Severn, above the mouth of the Wye; it then weighed 19 lb. If it was the Salmon that originally had the label inserted, and which, four months afterwards, weighed 19 lb., this would be important evidence; but there is some doubt as to which, of several fish that were caught, the label belonged. It only shows the danger of reasoning from an isolated fact. If it can be relied upon, it points to the fact that, in five months, the fish had increased 10 lb. in weight, and would also seem to show that the kelts only stay a very short time in the sea. It is, however, almost a solitary instance, and too much reliance should not be placed upon it as proving anything, one way or the other. As has been said, large rivers produce large fish, while small rivers produce small fish; and, in proof of this, the Tay, the Rhine, and the Severn are all cited as examples. It is difficult to see the reason for it, unless it be that the larger the river the larger the quantity of fish it breeds, and, if the large Salmon are only "survivals of the fittest," there are more likely to be more survivals, and, therefore, more large Salmon, in a large river than there would be in a small one. The estuary theory, which was Mr.

Buckland's, seems hardly tenable in the face of facts. He says that "the fatting grounds for Salmon of the Tay and the Rhine are of very first-class quality. Next to them come the Salmon pastures of the Severn." While fully admitting that the estuary of the Severn is one of the causes for the large Severn Salmon, one fails to see why, when the Usk and the Wye Salmon are also fed on the same pastures, the Usk and the Wye fish should not equal the Severn in size. All that can be said is that they do not—why they do not is one of the questions that has to be explained.

In the *Field* for August 1, 1885, an account is given of the capture of a large Salmon in the Dee, at Connah's Quay, said to be the largest fish ever caught in the Dee. It weighed 50 lb., was 4 ft. 2 in. long, and 2 ft. 3 in. in girth—not any exceptional dimensions either way.

It is very important to ascertain when the Salmon attains his full maturity, for, looking to the future supply of Salmon in our rivers, a very interesting and important piscicultural experiment waits to be worked out, namely, are the fry from mature Salmon stronger and healthier than the fry from immature? At present it is hard to say what, if any, fish are bred from mature Salmon, but it could be easily ascertained if the ova from large fish produced stronger and healthier fry than the ova from small, immature fish. There is not, so far as I know, any information existing on this point, yet it is one of great import-

ance, as it must, or ought to, be the object of all Fishery Boards to produce the best possible class of fish. At present there is no doubt that a quantity of the fry are bred from immature fish; this may or may not be an evil. In every other form of life one finds that the offspring of immature, is inferior to the offspring of mature parents. Does this rule hold true as to Salmon? There seems no reason why it should not. Buckland states, as the result of his experience, "the finer the parents the finer the fry."[1] Is this an admitted fact? It would be an experiment of great value if any one would breed three lots of fry—from grilse, from gillings, and from Salmon—and see which were the strongest fish, and which came quickest to the smolt stage. It cannot be too often repeated that the most important duty of Conservators is to get the smolts produced as quickly as possible, and in the best condition, and everything that goes to show how this is to be done will be of the greatest practical value. One of the reasons that so many immature fish are allowed to breed is the size of the mesh of the Salmon-net. As a rule, it is said that a large mesh is an advantage for the river; and, if by that is meant that a large-meshed net catches fewer fish than a small one, then, as all the English and Welsh rivers are understocked, and cannot afford to have a large quantity of their fish taken, doubtless this is so; but if it appears that

[1] Fourteenth Report, p. 65.

breeding from small, immature fish produces small fish, then it is doubtful if the use of a large mesh is such an advantage. At present there is hardly any evidence on this point, but there is this fact, that may or may not be traced to it. On the Usk, for some years—from 1868 to 1873—the average size of the grilse increased annually, and, although it has fluctuated since, in only one year since that date have the grilse exceeded the average size of 1873.[1] The stock of fish in the Usk is probably, in spite of the outbreak of the disease in 1883, larger now than twelve years ago; yet it is hard to see why the average size of the grilse should fall off. Of course, if it was the average size of the whole take, that would fluctuate with the number of the grilse in each year; but the average of the grilse alone points to some such cause as breeding from small fish. To set against this is the fact that the average size of the Salmon does not seem to decrease, and this would appear to destroy the other theory, unless what has been previously said is right—that the Salmon are the result of various years' breeding. It would be most interesting to know what the comparative size of the gillings during these years has been.

The following Table, compiled from the Usk reports, brings out the above points:—

See the Table on p. 91.

AVERAGE WEIGHT OF GRILSE AND SALMON.

	Grilse. lb.	Salmon. lb.
1868.	4·50	12·06
1869.	4·79	11·11
1870.	5·04	11·67
1871.	5·40	12·72
1872.	5·53	12·96
1873.	5·95	12·24
1874.	5·19	12·81
1875.	5·01	12·55
1876.	5·68	12·39
1877.	5·49	13·54
1878.	4·94	13·72
1879.	—	—
1880.	5·60	14·30
1881.	5·23	12·05
1882.	5·08	11·73
1883.	6·03	11·52
1884.	5·16	12·73

This Table shows the fact that the average size of the Salmon is not increasing on the Usk, or, if increasing, only in a very slow ratio. It is also most interesting as showing that, while the grilse decreased in size, the Salmon did not. Up to 1873 there had been a steady increase in the grilse average, while the Salmon average had fluctuated. But while it fluctuated, it fluctuated upwards; the grilse has also fluctuated, but downwards. It would have been expected that some connexion could have been

traced between the grilse and the Salmon, but from the Table this seems quite hopeless to attempt. It is curious to contrast the Usk table with the Severn table for the same years, on the next page.

In doing this, it must not be forgotten that the Severn average *includes* grilse, while the Usk *excludes* them. If the Severn average excluded grilse, it would be very much higher. The low average on the Severn in any year means a good run of grilse.

A very curious point as to Salmon is brought out by the Usk report as to the times at which the different sexes of Salmon frequent the rivers. For the months of June, July, and August, the only months during which observations appear to have been made, the following per-centage of males and females was noticed :—

	June.	July.	August.
1872.	13	27	31
1873.	13	24	49
1874.	14	29	24
1875.	—	—	—
1876.	12·76	16·94	26·35
1877.	7·5	10·22	20·38
1878.	—	11·76	9·09

The average of six years, ending 1874, was :—

June.	July.	August.
13	29	29

The average of nine years, ending 1877, was :—

June.	July.	August.
7·63	13·31	22·83

lbs.
10
10¼
11
11¼
12
12¼
13
13¼
14
14¼
15
15¼
16
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884

These figures bring out the fact that, in certain years, there is a far larger stock of males than others; and it may or may not be a coincidence that, looking at the Severn returns, the years of the most males on the Usk were bad fishing years on the Severn. It would be very important if more explanation could be given why in certain years the number of males is greatly in excess of what it is in others, and if this has any effect on the spawning seasons.

Another point arises in connexion with this theory from the Tables of the weight of the fish taken on the Usk. It will be found that the average of the seven years previous to 1875 makes the male Salmon a larger fish than the female in the months of June and July, but smaller in August. With the grilse, the males are larger than the females in the whole three months, but much less markedly so in the grilse than in the Salmon. The figures are:—

SALMON.

	June.	July.	August.
Males	15·27	13·13	10·18
Females	13·31	12·74	13·46

GRILSE.

	June.	July.	August.
Males	5·66	5·48	5·87
Females	—	5·25	5·65

The average for the sixteen years previous to 1884 bear this out still more markedly:—

SALMON.

	June.	July.	August.
Males	15·00	13·79	11·48
Females	12·54	12·59	12·69

GRILSE.

	June.	July.	August.
Males	5·25	5·58	5·92
Females	5·63	5·22	5·53

This may, as to Salmon, be accounted for by the increasing weight in the roe as the autumn draws on; but the explanation fails as to the grilse, and it is hard to see what is the real one. These figures also serve to prove that the large fish that run up the river earlier in the year are mostly females, and that, as a rule, the males are later in entering the river than the females; for the Usk reports also show that, on an average of sixteen years, the per-centage of males to females caught in each month was as follows:—

SALMON.

June.	July.	August.
10·99	17·58	25·09

GRILSE.

	July.	August.
—	15·71	27·57

It is difficult to offer any explanation of this fact: it would be interesting to know if it is universal. If it is, it introduces a very important point in Salmon preservation, for if, in addition to the fact that the spring run of fish are those that most readily reach the spawning-grounds, it is also true that a very large per-centage of them are females, then, having regard to the fact of the preponderance of male fish at spawning-time, a very strong case is made out for the spring extension of the annual close-time. It seems to be worse than folly to kill down the female fish on their passage up the river. The Usk figures certainly appear to point in this direction, and if other rivers give the same evidence, then this is a point that demands consideration from Fishery Boards.

One reason for the early run of female Salmon may be found in the fact that the female fish would in preference travel before her ova was fully developed. It must make some difference to a fish surmounting obstacles, whether she carries 4 oz. or 60 oz. of roe. On May 9, 1873, a Salmon of 17¼ lb. was caught; her roe weighed 4 oz. On October 17, 1873, a 20 lb. Salmon was caught whose roe weighed 60 oz. The following Table, taken from the Usk reports, shows the difference in condition of the fish at different times, and the proportion of roe and milt to weight.

ROE

			Salmon weighing.	Ova weighed.
1869.	May	24.	12½ lb.	2¾ oz.
1870.	„	25.	11 „	2¼ „
1871.	Sept.	15.	12½ „	20½ „
„	„	16.	9 „	21½ „
„	Oct.	6.	13 „	39 „
„	„	10.	13½ „	41 „
			Salmon or Grilse.	
1872.	Sept.	12.	14 lb.	32 „
		... ...	4 „	3½ „
„	„	14.	6 „	10 „
„	„	18.	4½ „	9½ „
„	„	21.	5¾ „	10 „
„	„	27.	6½ „	13 „
„	Oct.	5.	8½ „	21 „
„	„	15.	17½ „	26 „
Ova per oz.				
219.	„	14 & 17.	15 „	27¼ „
373.		„	15 „	23¼ „
196.		„	14 „	35 „
244.		„	12 „	23¼ „
			Salmon weighing.	
1872.	Oct.	14.	15 lb.	40 „
„	„	24.	14 „	36 „
„	„	25.	14 „	42 „
„	„	30.	11 „	32 „
„	„	30.	13 „	50 „

ROE—(*continued*).

			Salmon weighing.	Ova weighed.
1873.	May	9.	17½ lb.	4 oz.
„	June	7.	12 „	5 „
„	Sept.	17.	6 „	9 „
„	„	19.	15 „	25 „
„	„	„	18 „	32 „
„	„	„	21 „	42 „
„	„	„	21½ „	48 „
„	„	26.	6½ „	22 „
„	„	27.	22 „	37 „
„	Oct.	1.	24 „	52 „
„	„	2.	15 „	48 „
„	„	13.	20 „	56 „
„	„	14.	23 „	44 „
„	„	17.	20 „	60 „
„	„	20.	18 „	28 „
„	„	„	16 „	25 „
„	„	„	10 „	30 „
„	„	„	14 „	32 „

MILT.

			Salmon weighing.	Milt weighed.
1872.	Oct.	8.	23½ lb.	17½ oz.
„	„	26.	10 „	6 „
1873.	„	17.	21 „	9 „
„	„	18.	21 „	10 „

MILT—(*continued*).

				Salmon weighing.		Milt weighed.
1873.	Oct.	20.	... ...	7 lb.	... ...	6 oz.
„	„	„	... ...	12 „	... ...	7 „
„	„	28.	.. ...	7 „	... ...	7 „

SEWIN.

1872. Oct. 17. One female sewin 3¾ lb. Ova weighed 7½ oz. 236 ova per oz.

These Tables show very clearly the development of the Salmon ova. A fish in May will have 4 oz. of ova ; in October 26 oz.

It would seem that in some females the ova is heavier than others, as in two 15 lb. fish taken in October about the same date there is a difference of 4 oz. in the ova, while in the same two fish the difference in the number of ova to the ounce is very remarkable, no less than 154 ova in each ounce ; while a 12 lb. fish caught at the same time had very nearly the same weight of ova, the difference being only a quarter of an ounce, 23½ and 23¾, the 12 lb. fish had only 244 ova to an ounce, while the 15 lb. fish had 373, a difference of 129 to an ounce, or a total difference of nearly 3,000 ova (2,967). It would be very interesting, if it were possible, to obtain some information as to the condition of the fish in which such great differences of the number of ova are observed ; for it is obvious that the fish carrying the

greatest number of ova to the ounce are the fish that it is all-important to cultivate, if the fish hatched out from such ova are as healthy as the fish hatched out from the fish carrying fewer ova. It is very difficult to formulate any proportion between the weight of the fish and the weight of the ova, but some such rough rule as this may be taken, that in the spring the ova bears the proportion of from a quarter to half an ounce to the pound, while in the autumn it varies from two to three ounces to the pound. There is one other problem connected with ova that the Tables do not bring out so clearly, namely, do grilse have as much or more ova in proportion to their weight as Salmon; and does more grilse ova go to the ounce than Salmon ova? This is a question that, so far, we have no information upon. As to milt, there is no evidence of the relative weight of the milt to the fish in the spring of the year; but it is very striking how much less weight the male fish has to carry than the female. An ounce to the pound would seem the maximum proportion of milt. It is stated by Mr. Buckland, that on a 48 lb. Rhine Salmon he dissected, he found five ounces of fat on the pylorics; while on a fish with the milt developed, the amount of fat is very small, if it is found at all. It would be a question of some interest to observe the proportion between the fat and the milt, and to ascertain if in diseased fish the same proportion noticed in healthy fish is maintained. I cannot help thinking, but I have no evidence upon the fact, that there is some

connexion between this and the outbreak of disease in unhealthy male fish.

Certain years seem to be good Salmon years in all English and Welsh rivers, while others seem to be equally bad. It would, of course, be most important to trace the causes of the good and bad years. 1862 was a year that was exceptionally good, and none of the modern Acts of Parliament could have affected it; 1883 was another. It may be difficult to explain exceptional seasons on particular rivers; but surely one ought to be able to ascertain some of the concurrent causes that make a year exceptionally good; and if all the causes do not exist in each river, it then becomes most instructive to learn what is wanting; and still, if the season is good, then all these matters become still more important. It is so difficult to get any reliable returns as to the take of fish, that this is, perhaps, one of the hardest problems to solve; it also involves such a number of other points, that one always finds that no two observers on different rivers have each considered the same facts. The Usk has a return of the fish caught by rod and line which is reliable, but the rod-fishing depends so much on the rainfall, that it is not so valuable as a complete return of all the fish taken would be, for a bad rod season means a good fixed-engine season. The Severn has a return that may be regarded as approximate, while there is no information worth speaking of to be got from the other rivers falling into the Bristol Channel, except from the Avon,

Brue, and Parrett, which practically breeds no fish, but catches in the fixed engines at the mouth of the Parrett some of the migratory fish on their return to other rivers.

The Usk return is as follows, but it must be remembered it applies to rods only.

	No. of fish.		No. of fish.
1871.	763	1878.	1,241
1872.	1,970	1879.	3,556
1873.	2,113	1880.	1,267
1874.	700	1881.	1,702
1875.	1,129	1882.	2,452
1876.	566	1883.	2,047
1877.	1,537	1884.	825

It will be seen that the great years on the Usk are 1873, 1879, 1882, and 1883,—1873 was owing to a wet autumn; 1879 was a year with continuous high water, so much so that the Usk Association caught so few fish in the nets that it did not make the usual return; 1882 was another year of high water; and 1883 was, as has been said, an exceptionally good year everywhere. The Severn Table shows all fish taken in every way; and here the weather has not much effect; what effect it has is the contrary to the Usk, for as all the Severn fish are caught in the estuary, a wet year, which tends to take the fish from the estuary, tends to reduce the Severn catch; and it may, indeed, be said that a large year with rods on the Usk should be a small year with nets on the Severn. 1873, a

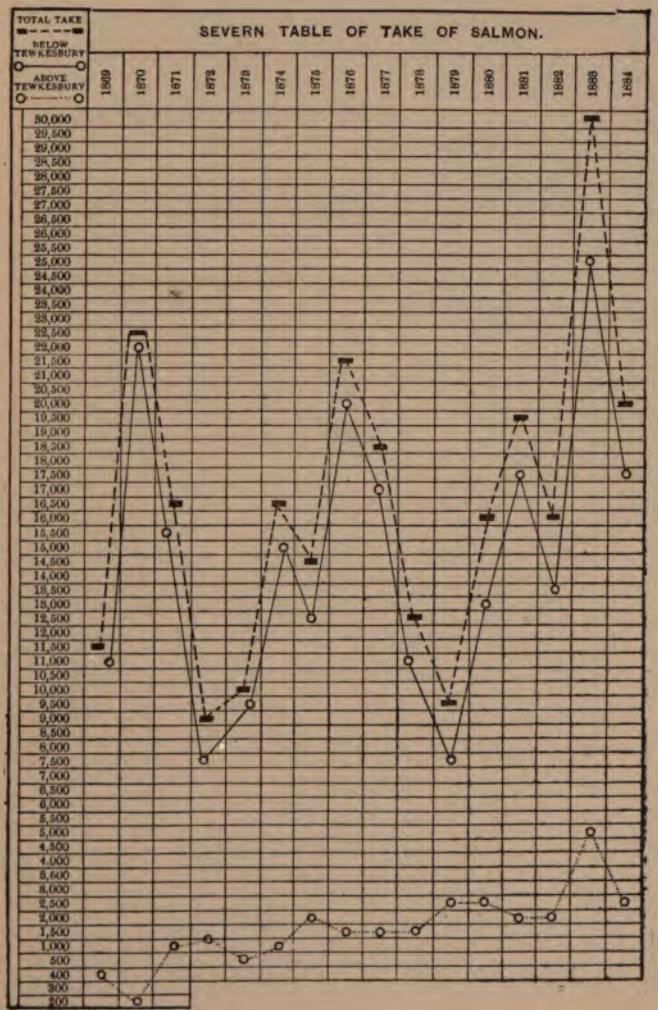
good year on the Usk, was a very bad one on the Severn; so was 1879—the worst year but one that has been recorded on the Severn; while 1876 and 1884, both good years on the Severn, were both bad ones on the Usk. This may be put down to the weather, but 1883, which was good on both, yet remains to be explained.

The Severn Table seems to point out that a good Salmon year is a distinct effort for the river to make, and exhausts it for a time; one or two years seem to lead up to it, then afterwards, for a year or two, there is a falling away. From the Table, 1870, 1876, and 1883 all point this way. After 1870 there was a falling off for three years before the effort was recovered; it took three years to lead up to 1876, then there was a fall for three years, and it took three years to prepare for 1883.

There are so many questions that surround the Salmon that it is impossible even to state any but the more important. I have carefully limited those I have given to the point to which Conservators' attention ought mainly to be directed,—how can the greatest amount of food of the best quality be produced in the shortest time?

The questions are:—

1. When does a Salmon reach his full size?
2. How often does a Salmon return to the sea?
3. What is the age of a 40 lb. Salmon?
4. Does a Salmon increase in size on each return from the sea?


SEVERN TABLE OF TAKE OF SALMON.
TOTAL TAKE
BELOW TEWKESBURY
ABOVE TEWKESBURY
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
30,000
29,500
29,000
28,500
28,000
27,500
27,000
26,500
26,000
25,500
25,000
24,500
24,000
23,500
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8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
400
300
200

5. Is there any difference in the size and health of smolts bred respectively from grilse, gillings, and Salmon?

6. At what time do the male and female Salmon usually run up the rivers?

7. When do the heaviest fish run up?

8. What are the causes that produce a good Salmon season?

9. Are any exceptional natural causes to be noticed in a good Salmon year?

CHAPTER VIII.

MIGRATION.

IT is usually said that the Salmon is a sea fish, and only resorts to the fresh water to breed. If this could be accepted as the true explanation of his journeys, there would be little to be said on the question of migration; but it is very doubtful if this can be so accepted, or whether the Salmon is, after all, a sea fish. Other migratory fish, who live in the sea and resort to the fresh water to breed, are totally different in their habits from the Salmon; they ascend the rivers, breed at once, and return to the sea. The most notable are the shad and the lamprey. About May both these fish ascend the rivers, and remain in fresh water for a period of some three weeks or a month, spawn, and then return to the sea. With the Salmon the case is very different; in a large river there is hardly a month, if there is one in the whole year, in which clean Salmon may not be found. Clean-run fish are found in January that, so far as we know, will not spawn till the next autumn, and it is hard to say that these fish have ascended the river to breed. If that is the object of the Salmon, it follows a different course from any other animals

that migrate to breed. What the Salmon does migrate for it is difficult to say. The Salmon does breed in fresh water, therefore it is assumed he migrates for that purpose. Some Salmon certainly do, but it is difficult to believe that is the explanation of spring-run fish. On every river there seems to be a certain fixed number of runs of Salmon in the year, and it is one of the most important questions connected with Salmon to ascertain, and, if possible, account for, their migrations,—when are they, and what are the fish that make them? On the Severn there are at least eight distinct runs of fish :—

1. In January, or just at the end of December, a run of spawning-fish, generally the largest run in the season ; these are usually fine fish, but not of any excessive size.

2. In the end of January or February, or even later, a run of spawning-fish ; these are much fewer in number, but are generally very large fish.

3. A run of clean fish in February ; these are all large fish, mostly Salmon, but towards the end of the month some gillings.

4. The spring run of gillings, February and March; these are very strong, active fish, and press up the river at once, those that get to the top form the early spawners for the next season.

5. A small run of grilse in April, or, rather, of small fish ; some of these are grilse, but many are small Salmon.

6. The great run of grilse in June and July.

7. The autumn run of fish; these are locally spoken of as the Michaelmas gillings.

8. The great run of spawning-fish in October and November.

All these runs do not occur in every year; for instance, there may be no grilse or gillings, or but very few—in a good year they would all occur. They may be classed as three distinct runs of spawning fish, and five runs of clean fish, namely,—the spring and autumn run of clean fish, February and August; the spring and autumn run of gillings, and the run of grilse.

It would, then, seem that of each class of fish—grilse, gillings, and Salmon—there are two migrations in each year. In addition to this, there are continual migrations of individual fish going on. Throughout the season, fish are moving up from the tideway. Of course, the number of these fish depends on the stock in the river; but all the year round, in large rivers, clean Salmon are moving up; in the autumn very few, but more about December and January, and so on through the year. It is to the fish that return singly that weirs do so much harm; the fish push up even in low water, and would make their way up the river little by little, but in low water they are stopped by the first weir they arrive at, and either drop back or remain in the pools below, and it is doubtful, if they once remain, how long they will stay. They seem to be content with their quarters, and to lose their migratory impulse. A large run of fish never

comes but with a rise in the water; but these stragglers, until they make up their minds to stay in some pool, are always moving on up. One instance will show this: the Worcester net fishermen always go out fishing on a Monday morning, however low the river, because they say fish will always work up so far. They do not fish the greater part of the week in dry weather; but the effect of the weekly close-time in stopping netting for two days generally gives them fish on the Monday.

The following account of the number of runs of Salmon on the Forth has been furnished me by a correspondent. It is interesting to compare it with those on the Severn:—

"There are every season five runs of Salmon and two of grilse. The great run of Salmon commences in December with the first spring tide,—our winter Salmon. They are large, coarse fish, from 16 lb. to 30 lb., very lively in the net when caught, and very bold on the rod and line. The second is the first run of the young Salmon, or spring fish; they are a fine-made and delicate-looking fish, very lively, from 1½ lb. to 10 lb. They first appear in February, rising 1 lb. each spring-tide. The third is our summer Salmon,—a short-made fish, very sluggish in the net or on the rod, 12 lb. to 30 lb.; are first seen in May. The fourth are our autumn Salmon,—rather a smart fish for size, give great play on the line, appear in July, run from 16 lb. to 40 lb. each; the milt and roe appear far advanced; the male has a long beak.

The fifth run are peculiar-looking fish, generally of a dark colour, some red and spotted; the male has a large milt and a very large beak; the female a very large roe. They give great annoyance to anglers, constantly leaping and disturbing the water; 12 lb. to 30 lb. each. It was supposed by the old fishermen they were the real breeders. If a wet autumn, they appear September 1; if dry, not till October 1. The first run of grilse appears in May, 1½ lb. to 5 lb., very lively, very delicate-looking fish, and not unlike the young Salmon. The second run of grilse appears in July, short and thick, 5 lb. to 17 lb., and the following year are found 24 lb., but called Salmon. The third run of grilse is what they call the 'grey schule,'—a dark-brown fish. If a dry autumn, they come in September, near the end; they rise freely to the fly, and seem destined for breeders."

Without agreeing with all my correspondent's observations, it is interesting to find that he makes the number of migrations of fish on the Forth much the same as I do on the Severn. There is considerable difference in time and in other details, but a close resemblance in the main outlines. It is stated in Mr. Buckland's 17th Report[1] that on the Hampshire Avon the estuary fishing begins in March, and goes on to June and July, the large fish are all passed by the middle of June. Then the grilse begin; the average weight this season, 1873, he says, "is 16 lb. per fish;

[1] Page 18.

and in the month of August only small fish come up; not one in ten weighs over 7 lb." I have not been able to get from any other river any information as to the number of runs of fish in the course of the year; but it would be very important if it could be done, for if there is anything like uniformity, and there are eight distinct migrations in most rivers in every year, it suggests a number of new considerations in Salmon preserving. First, are these migrations *from* the sea in any way connected with migrations *to* the sea? and, if so, what is the relation between them? We have hitherto considered that there were only two seaward migrations, both in the spring: the old kelts who had spawned, and the smolts. If that is right, then how is it that the migrations from the sea are so much more numerous than the migrations to the sea? It would mean nothing, if the same kind of fish was found in each migration from the sea; but when different fish are found taking part in the different migrations, and these different fish appearing nearly always at stated times, it does seem difficult to believe that there is no fresh-water migration corresponding to the seaward migration. Any data or any observations on any river that will give any reliable information as to the number of migrations, either way, will be most valuable. There is an old fisherman's saying, that "Salmon only run well on a spring tide," and no doubt it is on a spring tide that the largest run of fish occur; but there is also no doubt that every tide the fish run up the estuary a certain

way, and fall back with the ebb. For the greater part of the year,—at some times much more than others,—the fish congregate in the estuary, and remain there. Some few work up each tide, but the majority wait for a fresh before they leave the estuary. It is this that makes the estuary fisheries so valuable; the fish remain there tide after tide, and the fishermen have ample time to take them, while, when the fish have started inland, they are moving upwards, and, unless caught when moving, have passed, and are not met with again.

The fish seem to congregate most in the estuary in the summer and early autumn. I say "seem," for the reason that the water-bailiffs find more fish stranded on the sands after each tide during those months than during any others. It may be that the fish equally congregate in the winter and spring, but that the higher land-water coming down at those times makes them take the rivers more readily than during the summer and early autumn, when, the rivers being low, the fish hang about, and appear to congregate more in the estuary. It may also well be that in low water they do not care to face the pollutions through which they have to pass, and wait for a rise of the water before they try it. Whatever is the reason, there can be no doubt the fish hang about the estuaries for some time in the summer and autumn. Then arises a question that is difficult to answer. In an estuary like the Severn, into which several rivers flow, do the fish wait for a fresh down

the stream in which they are bred, or do they go up the first stream down which a fresh comes? Or, to put it differently, do the fish when coming in from the sea go up the first fresh stream they reach, or do they go on until they reach their own river? It is this question that was alluded to before as the hereditary question.[1] I think that probably the truth lies in giving no very decided answer to either question. I feel sure that the fish from the Usk and Wye come up the Severn to a certain point above the mouth of the river; whether they go back again I cannot say, but they certainly wander about the estuary, and I am inclined to think (but on this I cannot speak certainly) that while some of the fish are always working up, the bulk wait until a fresh comes down, and then start up.

In the lower Severn there are, no doubt, different kinds of Salmon met with. There is the ordinary Severn fish; a longer and lankier fish, that is said to be a Wye fish; and a short thick fish, that the fishermen speak of as "Uskers." I have not met with either of the last two kinds above Tewkesbury weir, and I cannot say if the names locally assigned to them are right. Salmonidæ, from the same river, present such varying forms, that it is almost impossible, even for the most experienced, to say positively that such and such fish belongs to a particular river. All that can with certainty be said, is that a portion of the catch of the Severn are bred in

[1] See *ante*, p. 25.

the Wye, that the fish taken as far as the Severn bridge probably belong to either river; but I have no evidence to show that if a fresh came down the Severn, the Severn fish would alone ascend, and leave the Wye fish in the estuary waiting for a Wye flood. This is one of the points that, if marking fish were carried out on a large scale, might be cleared up. This fact should also be borne in mind in reading the reports of the Inspectors of Fisheries when they institute comparisons between the Severn, Wye, and Usk, and state that the Wye take has increased, and the Severn fallen off, and wonder how it is to be accounted for, as it is by no means clear that the take of the district has fallen off, for the increase of the Wye in tidal water may represent Severn fish, or *vice-versâ*. When the river has a common estuary, and the districts are divided by an imaginary line, it is impossible to say what fish rightly belong to each river.

Fish are usually expected to run at certain times, but they by no means run with regularity, a very little puts them off running. I leave out, for the present, considerations of water and temperature. Fishermen always say that a shoal of porpoises, getting between a run of Salmon and the river, effectually prevent the entrance of the fish at times. They also say, which seems too preposterous to be true, that sturgeon, by routing and poking about in the mud, frighten the Salmon, and so prevent them ascending the river. The Bristol Channel swarms with porpoises, and when that is the case the Salmon are said

not to run. It is said that the scars on Salmon show the wounds they have received from the bites of porpoises; it is at least clear that porpoises feed largely on Salmon. One year it was said there were 500 porpoises inside the mouth of the Usk. At another time a number were observed almost in line across the mouth of the river, feeding on the kelts as they descended seawards. It may be safe to assert that Salmon will not run through a shoal of porpoises; but then comes the question, What becomes of the Salmon? Do they drop out to sea again, or only lower down the estuary? At times, so far as the estuary fisheries go, Salmon seem very scarce indeed, and to have deserted the estuary entirely. Do they go out to sea again; and, if so, how long do they stay there? Here, again, there is no direct evidence. One curious fact there is. It is said by Mr. Buckland,[1] "that a larger number of Salmon than are due to the Fowey leave the sea, and play about at the mouth of the river. These fish come in from north, south, east, and west. They are big fish, from 25 lb. to 30 lb. in weight. They come late in the year. They have very white bellies, and very black spots on the sides. They are very fat and great, different in every way from the mature Salmon of the Fowey." Mr. Buckland adds: "I am quite at a loss to account for these fish." Can any explanation be given of them?

In fresh water, on a clean Salmon ascending the

[1] Twelfth Annual Report, p. 35.

stream, if he is disturbed or obstructed, he drops back. As to this, there are several bits of evidence. A fish on the Wye was hooked ; broke away. The same fish was taken with the fly in his mouth the next week, half-a-mile lower down the stream. A fish, this year (1885), was seen in a net at Powick. It got out of the net. As it got over, one of the fishermen hit it with the boat-hook, and marked it. A fish so marked was caught two or three days afterwards, some way lower down the river, although there were several deep pools between where it might have stopped. If ascending fish reach a mill after waiting a day or two in the pool below the wheel, if not gaffed, or otherwise killed, they nearly always drop back down the river. A poacher who tries to gaff a fish, always, if he misses it, looks first in the pool *below* for the fish, never, if he knows his work, in the pool above. All this evidence goes to show that if a clean fish is interrupted in his journey up stream in fresh water he drops back. Does this apply to tidal waters? If fish were in the estuary, and met with any serious obstruction, would they drop back seawards? The question is important in two ways. If the fish drop back and remain in the lower waters, then the nets and fixed engines get a double turn at them, and the chances of the fish escaping and ascending up the river are greatly decreased ; and if the effect of an obstruction like a weir is not merely to delay the fish in the pool at the foot, but to cause them to drop

back, then the existing Fishery Acts require important amendments to prevent the fish that are ascending the river being caught. It was, by the Act of 1873, made illegal to fish 50 yards above, and 100 yards below, any weir, the idea being that the fish would rest in that space; but if the fish drop down beyond that distance, then the existing law gives no protection whatever to the fish that are obstructed by the weir, and Boards of Conservators and the Legislature, who have considered the fish amply protected, are really imagining a vain thing.

It is a curious fact that, as regards kelts migrating seawards, the effect of obstruction is just the contrary to that of clean fish running up. Kelts always, if obstructed, strike up stream; while, as has been said, clean fish run down stream. If clean fish are obstructed, and drop back to a pool, how long do they remain? I shall be told, till the next fresh, but I am by no means sure that is the case, or that fish that have got a certain distance up a river move onward at each rise of the water. My reasons for this are that I have known that fish of a certain description were in a particular pool, a flood has come, and, after it has gone down, fish of the same description, are still there, and I do not think clean-run fish, for they were not light enough for that. This is, however, one of the points on which some information is wanted.

The question as to what is the object of the spring run of clean fish is one that demands attention. It

is clearly not to breed, as a fish would hardly migrate in February or March to breed in November, even if it does breed then. It has been suggested that these fish are barren fish, but against that view is the fact that they have milt and roe, but only in an undeveloped state, and that, as the year gets on, the milt and roe become more developed. If the Salmon is a sea fish, why does he come to fresh water to spend so much of his time? Buckland's explanation that they are a secondary migration of Salmon—a spring migration in contradistinction to an autumn migration—does not help matters. No one denies that they are a secondary migration; but what one wants to ascertain is, why, if the Salmon only resort to the fresh water to breed, these fish should come in February and not breed till October. No satisfactory explanation of why they come to the river has ever been given. It is said to be a fact that on the seaward migration Salmon fry go first, then the grilse, and then the sea-trout. I have never been able to test this, or prove it in any satisfactory way, but a similar saying is met with on the Forth, and it would be curious to find out the truth of it.

The Usk Fishery Board has done more than any other to observe the migration of Salmon, and some of the facts they have collected are most instructive; the curious thing is that some of them do not coincide with such observations as have been made on the Severn. Unfortunately there are no materials I know of to give any account of the migration of

fish on the Wye. The Usk Board have a series of observations, extending from 1868, showing the weight of Salmon (using that term to include both Salmon and gillings) taken in the fresh water in the Usk by the only net used there, for the months of June, July, and August in each year. The observations also distinguish between the sexes of the fish. Taking the sixteen years over which the observations extend, it appears that, taking both sexes, the fish caught in June are heavier than those caught in July and those taken in July lighter than those taken in June, but heavier than those taken in August, the figures being, June, 12·64 lb.; July, 12·50 lb.; August, 12·49 lb. The observation applies only partly to grilse, the average for 16 years being for the grilse, June, 5·64 lb.; July, 5·21 lb.; August, 5·59 lb.. The heaviest grilse are caught in June; but with grilse, those caught in July are lighter than those taken in August. It may be that more are taken in July, and that brings down the average.[1] Both Tables, as to Salmon and grilse, are worthy of much careful study; they suggest some very curious and important questions on Salmon migration.

[1] See the Table as to grilse on p. 93, *ante*.

SALMON.

Average weight in pounds of Salmon taken in the Usk Association's nets during the months of June, July, August, from 1868–1884.

	June.			July.			August.			Average of the Three Months.		
	Male.	Female.	Monthly Average.	Male.	Female.	Monthly Average.	Male.	Female.	Monthly Average.	Male.	Female.	Total Monthly Average.
1868 ...	...	...	...	...	...	12·06	...	...	...	...	...	12·06
1869 ...	...	...	15·00	11·81	11·25	11·11	...	...	...	11·81	11·25	11·11
1870 ...	...	...	11·71	...	...	11·70	...	...	11·61	...	...	11·67
1871 ...	...	...	11·25	...	...	...	...	...	13·20	...	...	12·72
1872 ...	12·00	15·92	15·40	13·76	12·95	13·28	10·60	13·72	12·73	11·24	13·65	12·96
1873 ...	14·16	13·65	13·70	14·04	13·71	13·79	9·56	13·48	11·53	10·30	13·58	12·24
1874 ...	15·85	12·91	13·34	13·60	12·79	12·83	10·42	12·93	12·32	12·42	12·88	12·81
1875 ...	14·37	11·40	11·66	14·66	11·65	12·20	15·35	12·63	12·95	15·01	12·20	12·55
1876 ...	13·75	12·24	13·08	12·65	12·15	12·23	11·76	12·35	12·21	12·18	12·45	12·39
1877 ...	15·33	14·47	14·53	17·11	12·52	12·99	13·36	13·80	13·71	15·08	13·32	13·54
1878 ...	...	14·42	14·42	15·05	13·89	14·03	12·66	12·87	12·85	14·45	13·63	13·72
1879 ...	No return.											
1880 ...	20·00	13·85	14·07	32·00	13·26	14·43	15·65	14·03	14·34	16·59	13·92	14·30
1881 ...	14·00	11·69	12·16	12·87	12·03	12·16	13·11	11·35	11·65	13·10	11·85	12·05
1882 ...	...	10·25	10·25	...	...	...	13·09	11·57	11·80	13·09	11·51	11·73
1883 ...	16·33	10·69	11·06	13·75	10·73	11·48	12·77	11·24	11·69	13·23	10·98	11·52
1884 ...	18·39	12·41	13·16	17·15	12·01	12·55	11·61	12·78	12·59	14·84	12·36	12·73
Average of 16 years.	15·00	12·54	12·64	13·79	12.59	12·50	11·48	12·69	12·49	12·56	12·58	12·52

The sex not having been in every instance recorded during the first year or two of the observations, the total averages are drawn from a somewhat larger number of fish than those of the males and females.

As to Salmon, it appears that in June the male fish are heavier than the females; the average over sixteen years gives the weight of the males 15·00 lb., the females, 12·54 lb. In July the weight of the males has very much decreased, while that of the females was slightly increased, the weight of the males being 13·79 lb.; the females, 12·59 lb.; while in August the weight of the males had decreased to 11·48 lb., and the females had increased to 12·69 lb. It is difficult to suggest any answer to the question why large male fish should be more plentiful in June than in July or August. The difficulty is not lessened when the figures as to the grilse are examined; it will then be seen that in June the female grilse are heavier than the male, the average weight being, male, 5·25 lb.; female, 5·63 lb. In July the male grilse average 5·58 lb., and the female 5·22 lb., while in August the males average 5·92 lb., and the females 5·63 lb. So that the figures as to Salmon are reversed when applied to grilse, the male being smaller in June and larger in August, while in Salmon, the largest males are found in June. I must at once confess I cannot offer any explanation of the result of these observations, and should be only too glad if I could hear any reasonable explanation. According to the Usk observations, the male fish—and this remark applies equally to Salmon and grilse—enter the river later than the females.

The following Table from the Usk returns brings this out:—

PROPORTION OF MALE TO FEMALE SALMON.

	June. Per cent.	July. Per cent.	August. Per cent.	Remarks.
1872.	13	27	31	Preponderance
1873.	13	24	49	of males; out
1874.	14	5	24	of 29 fish, 8
1875.				females, 21
1876.	12·76	16·94	26·35	males.
1877.	7·5	10·72	20·38	
1878.		11·76	9·09	
Average for 10 years	12·23	18·2	29·04	

It will be seen that, on a ten years' average, the proportion of males to females in August is more than double the proportion in June It will be said that the number of males among the grilse will explain this, but this is only a partial explanation; for, admitting that there are more male than female grilse, and the run of grilse, therefore, increases the per-centage, the fact that the proportion of large males is as great as 12 per cent. in June seems to point to the fact that the earlier in the year the greater run of females. What is wanted to complete these Tables are some observations as to the relative proportion of the sexes in February, March, April, and May.

The increased per-centage of male to female fish taken in the Association's nets was also observed as to grilse. As will be seen from the Table given above, the per-centage as to grilse was in July 15·71; August,

27·57. One explanation of this may be found in the fact, if it be a fact, that the male fish swim up the river more quickly than the female. At all events, the higher up the river the netting takes place, the greater the per-centage of males to females caught. The importance, however, of the high per-centage of females in the early months of the year, from a Conservancy point of view, is, that as the quantity of male fish exceeds the quantity of female fish, the way to promote the fisheries by equalising the proportion is to extend the annual close-time, and do away with spring netting. It is unfortunate that no river but the Usk has any tabulated return to show as to the times when the male and female fish usually enter the rivers. My observations are almost too limited to quote ; but, as far as they go, they do not wholly bear out the Usk figures, but they are for the early spring months, not the summer months. I cannot say to what extent, but certainly a large per-centage of the spring-run Salmon on the Severn are males. This is just one of the questions that especially requires careful observation ; for if it can be satisfactorily answered, it might have a most important bearing on the fisheries.

The Salmon, when migrating from the sea, seem to follow a fixed track ; or perhaps it would be more correct to say that they follow the channel of the river. This is certainly the case with ascending fish. A map of the part of the river by which the fish ascend might easily be drawn; but while the fish ascend in the

channel, when the tide turns they do not follow it. This is shown from these facts :—1. The position of the fixed engines ; most of them, putts and putchers, fish comparatively shallow, and by far the majority of them in the Severn fish the ebb, and not the flood ; indeed, flood-putchers are the exception. If the fish took the same course in ascending with the flood tide as they do in descending with the ebb, one would expect to find the ebb and flood-putchers in nearly equal numbers. 2. The second fact is, that all the lave-net fisheries in the Severn are conducted in shoal water, and the fish in the lave-nets are always caught on the ebb. Why the Salmon should, when descending on the ebb, adopt a different course to what it does when ascending on the flood, remains to be explained. The Salmon seem to have regular tracks, and if for any reason they are diverted from these tracks, they are very slow to come back to them. A curious instance was seen at the Severn Tunnel. Before this work was begun, there used to be a good fishery just above the place where the Tunnel passes under the river. In consequence of the boring operations, chiefly the blasting, the fish have left that part of the river, and the fishery is almost worthless ; and although the blasting has now ceased for some time, the fish do not return.

One other point connected with the migration of kelts I am wholly unable to explain. At Powick weir there is a fixed trap for taking Salmon ; the fish that are caught in it are *ascending* fish, and those only; from its construction, a descending fish could not be

caught. In the spring, it often happens that kelts are caught in it as well as clean-run fish. For a fish to get into it, he must ascend the stream from the pool at the bottom of the weir to the trap; so these kelts must *ascend* to be caught. But at that time kelts are descending—what makes them reverse the process? To add to the difficulty, the kelts are usually caught when there is a slight fresh on the river, and when one would imagine they would take advantage of the fresh to migrate seawards, and not run upwards. I can only state the fact, and hope that some one who is more acquainted than I am with the habits of Salmon can furnish a solution of it. I do not know any other instance of kelts ascending the stream, unless obstructed in their downward passage, which here they are not. Can any other instance be given?

A curious point as to migration was started by Mr. Buckland. He says, speaking of the Salmon caught out at sea off the Tyne: "It is supposed many of these Salmon come over from Norway. My own opinion is that it is very likely that they come from a much greater distance than this. It is, indeed, not at all impossible that they may come from rivers that empty themselves into the sea within the Arctic Circle. We have not yet sufficient facts to confirm the above idea [query, have we any?]; but I think we do not sufficiently recognise the immense distances that Salmon can traverse in their migration."[1] Is there any evidence at all to warrant the conclusion that fish, say from Norway, migrate off the coast of

[1] Twelfth Report, p. 41.

England? Another passage in the same Report,[1] speaking of fish that appear off the mouth of the Fowey: "I am quite at a loss to account for these fish. The theory was started that they were Salmon wandering from Ireland, or even from America. Though it seems improbable, I am not altogether inclined to dispute the possibility of their being fish that have come over with the Gulf Stream from North America." Is there the smallest shred of evidence to warrant this assertion, or that we can look to the rivers nearest the Arctic Circle, or to America, to supply us with Salmon?

Another point as to migration it is difficult to explain. Salmon will not merely push up the river at breeding-time to points where there is good spawning-ground, but will push on to inferior grounds higher up the river. In fact, if there is water enough, and no obstacles, there is no limit to the points to which Salmon will ascend. Indeed, one of the great difficulties of Salmon preservation is this habit of the fish to leave the main stream, and spawn in small brooks and places where they can be easily killed by poachers. No satisfactory explanation has ever been given of this. The difficulties that Salmon will encounter, and the perseverance they show in surmounting these difficulties, is one of the most wonderful things in their history. Nothing seems to daunt them; they push on up the river, in spite of all obstacles. I remember once, in October, an old Welsh farmer, at whose house I was, offering me

[1] Page 35.

some lunch, and telling his wife to bring out Nelson; and he so often alluded to Nelson, and evidently thought him so great a treat, I became very curious to know what it was. To my surprise, a pickled Salmon, with an obvious gaff-mark, was produced. I asked why he was called Nelson, and was told that by the time the fish got up the river so far, he had encountered far more dangers than ever Nelson went through, and that, like Nelson in dying, he had done his duty. No part of the natural history of Salmon deserves more careful study than that of the migration of the fish. If the laws that govern it could be ascertained, we should have some guide to the fish harvest, and to what makes good and bad seasons. At present, beyond the fact that the Salmon do migrate, we know almost nothing, and the most important questions to ascertain with regard to migration seem to be:—

1. What makes Salmon resort to fresh water?

2. How many runs of Salmon are there in each river in the course of a year?

3. At what time of the year may these runs be expected?

4. What are the usual conditions for a good run of Salmon?

5. If Salmon when running are obstructed in working up, do they drop back to the sea; and if so, how long do they remain before running again?

6. If Salmon are obstructed in fresh water, do they drop back and leave off running?

7. Do Salmon only run in numbers, or do individual Salmon run up independently of any general run?

8. Do Salmon in an estuary ascend the first river down which a fresh comes, or do they wait for a fresh down the river to which they belong?

9. When do the heaviest Salmon run?

10. When do the smallest Salmon run?

11. When do the male fish chiefly run?

12. When do the females chiefly run?

I had written this chapter before I had the advantage of seeing Mr. Huxley's 24th Report for 1885. If anything was wanting to show the necessity of further investigation into the migration and habits of Salmon, this report gives the strongest evidence of it. It is only necessary to point out three things, upon which there is evidence which certainly does not bear out Mr. Huxley's conclusions. It is stated:[1] "In sundry rivers there are two or more periods of main run, when many fish ascend together; while in the intervals of these runs, or before or after them, ascending fish are few and far between." The fishermen between Worcester and Gloucester catch nothing but ascending fish. At times they catch more than others, but from February to September they each week catch a certain number of ascending fish. From this it is to be inferred that at all times during those months fish are ascending the river, in other words, all through the open season, and are not

[1] Page 27.

confined to particular great rushes, and are not few and far between at other times. It is stated on the same page: "Sometimes these periods of main run are far apart, and represent distinct early spring and late summer, and late summer or early autumn, shoals (*e.g.*, Eden); sometimes they are massed together in the summer months, (*e.g.*, Severn); sometimes, finally, they are deferred to late autumn—October, November, or even December (Avon and Erne)." I know nothing about the Eden, or the Avon and Erne, but the statement as to the Severn is distinctly incorrect; as I have tried to show, there are various runs of fish on the river, and very often greater runs in spring than in summer. It is also to be objected to the conclusions of Mr. Huxley, that the important distinctions between the migration of grilse, gillings, and Salmon are wholly ignored. All Salmon are treated as Salmon, and it is assumed that they resort to fresh water simply to breed, and the case of the shad is cited as an analogous case. The shad[1] is said "to migrate like the Salmon, though it does not go so high up the river;" but this is just what the shad does not do. It migrates solely to breed. The times of the shad migration last about a month, while to use Mr. Huxley's own words: "The difficulty is to understand why a Salmon should leave the sea months earlier than is necessary to give it time to reach its breeding-ground." I purposely abstain from offering any

[1] Page 26.

observations on so-called early and late rivers. I venture to think that we have not anything like sufficient knowledge upon which to base any conclusions. We may start theories, but they do not help us to arrive at results; for, until some clear facts are ascertained as to the migration of fish, it would be only a waste of time to lay down conclusions in which nothing is concluded, and it is with thankfulness that one reads the concluding remarks of Mr. Huxley:—"It is with the hope of stimulating exact observations to the periods at which Salmon appear—1. Off the coast; 2. In the estuary; 3. In different parts of the fresh water—that I have ventured to give the map in question, and, I trust, Boards of Conservators, and others interested in the subject, will contribute careful observations in respect of this, and other points connected with the natural history of the Salmonidæ, about which our knowledge is still far less exact than it ought to be." If one remark may be added to these, it is that it is the Inspector's duty to obtain from all possible sources such exact information, and not that of the Fishery Boards, who have no funds for the purpose; that it is one of the objects for which Inspectors were appointed, to show to the Boards of Conservators how to conduct these observations if they are able to undertake them, and that, until such information is obtained, it is unwise to legislate, or allow Boards of Conservators to legislate, and alter the existing laws.

CHAPTER IX.

MISCELLANEOUS.

THERE is no more important point connected with Salmon than the question, on what do Salmon feed? Mr. Buckland says: "sand-eels, shrimps, lug-worms, and the fry of sea-fish."[1] This is, doubtless, true, but is it all their food? if so, it leaves two questions quite unexplained; (1) What does the Salmon feed on in the sea? (2) What does he feed on in fresh water? All writers agree that the Salmon feeds *largely* in the sea. It is by his feeding there that he is said to increase so rapidly in size; but if his food consisted of what he could only get if in the estuary, why does he resort to the sea at all? Mr. Huxley says: "after the young have passed through the parr and smolt stages, the fish take food almost exclusively during its residence in the sea, and it grows and increases in weight *only* during this period."[2] Here again we get no information as to what the fish feeds on, but only that they do feed in the sea, but both Mr. Buckland and Mr.

[1] "Natural History of British Fishes," p. 298.

[2] Twenty-fourth Report, p. 25.

Huxley seem to agree that while in the river the Salmon take almost nothing. Is this so? Mr. Huxley reasons from the case of the herring, and states that "the herring at one period of its life, the so-called 'matie' condition, during which it feeds voraciously, grows, and finally lays up a great stock of nutritious matter, while the reproductive organs remain rudimentary; and this is followed by another period, during which the fish leaves off feeding, while the reproductive organs attain an enormous size at the expense of the nutritious matter previously stored up in the body. In this condition the herring is said to be 'full.' The milt or roe is then discharged, and the 'shotten' herring, as it is then called, recommences to feed."[1] From this Mr. Huxley argues that the spring-run Salmon is the same as the matie herring, the late autumn-run Salmon as the full herring, and the kelt as the shotten. But the analogy fails to account for two very important facts. Male Salmon in the parr stage have the reproductive organs very fully, if not abnormally, developed, and no angler but knows that they feed voraciously. If the explanation is correct, the parr is then full, and should not eat, but he does. Can it be said that the fact of a visit to the sea so changes the nature of the fish as to make it leave off feeding when its reproductive organs are most fully developed? It of course may be so, but is there any analogous case? if not, it

[1] Twenty-fourth Report, p. 25.

would require a great deal of direct evidence to prove that the mere fact of the full development of the reproductive organs causes the fish to pass through a period of abstinence. Secondly, is there any evidence to prove that, assuming the herring leaves off feeding in its full state, that the duration of that state in any way corresponds with the time that a Salmon resides in fresh water? A spring-run Salmon comes into the river in January or February. Mr. Huxley says there is no evidence that it will spawn before November. The evidence of the Severn goes to prove it would spawn in October; but take either month,—does the analogy of the herring in any way justify the inference that the Salmon will fast for nine months? It may be very well in the case of autumn fish who run up in November, spawn then or in December, and return directly to the sea; that is a case that very nearly resembles the case of the shad. But it requires some evidence far stronger than mere inferences from analogy to prove that a clean-run Salmon eats nothing for nine months, and does not decrease in weight. As yet there is no evidence that the Salmon only grows and increases in weight in the sea.

I am quite aware that the theory put forward by Mr. Huxley is the one usually accepted, but it rests almost wholly on negative evidence. No one sees a Salmon eat in fresh water; nothing is ever found in his stomach. No one ever heard of a

Salmon increasing in weight in fresh water. All this may be so, but before the question is affirmatively answered one requires some evidence whether Salmon do not feed in fresh water. There is a strong belief—I have never been able to verify it—among the fishermen of the Severn, that Salmon feed largely on elvers, the young of eels. It does not go for much, but an elver is a bait a Salmon will often take when he will take no other, and there is no reason why Salmon should not feed on elvers: indeed, they are one of the very things one would expect him to feed on. Worms, again, Salmon will greedily devour, and they frequently take worms as a bait. Of course, these facts don't go for much, still they are bits of positive against mere negative evidence. It should also be noticed that the Salmon is a fish of nocturnal habits. Any fisherman will say that the Salmon runs by night, and not by day. May it not well be that the fish feeds equally by night, and rests by day? Of course, if this is so, the fish would not be seen feeding; at least the number of observers who saw them would be very small, and if it is so this may account for the fact that so little is ever found in a Salmon's stomach, as what is taken in the night may be digested before the fish is caught. Until there is some direct evidence that the fish does not feed in fresh water, it will be by no means safe to assume that the time a Salmon lives in fresh water is a time of abstinence.

There is one other point to consider. If it is true

that the Salmon does not feed in fresh water, how is the land-locked Salmon accounted for? If Mr. Huxley's analogy between the herring and the Salmon is correct, then the land-locked Salmon ought almost exactly to pass through similar stages to the herring. I do not profess to know anything of the history of the land-locked Salmon, but it would be most important if some information as to its habits and time of breeding could be ascertained, as they would throw much light on these habits of the migratory Salmon in fresh water. So far as I know, there is no reliable evidence in existence as to the effect produced on Salmon as to its weight or size by its residence in fresh water. Mr. Huxley states that the Salmon grows and increases in weight only during its residence in the sea, but this again is only the popular idea. Of course, there is some little evidence that Salmon that run up in the autumn, and are delayed spawning, deteriorate in quality; but I know of none, one way or the other, as to weight. There is nothing that shows that a spring-run Salmon has either lost weight, or remains at the same weight, after three or four months residence in a river; he alters in colour, but does he in anything else? This is one of the points that can only be answered by observation, and a number of marked fish in different rivers would give some very interesting results. Of course, the fact may be as Mr. Huxley states it is, but there is no evidence of it at present. Indeed,

the whole question of Salmon food is one on which we are lamentably ignorant, and it is difficult to say how observations can best be made on it. The Usk Salmon at the Brighton Aquarium gives a few hints, but that fish's history is complicated with the difficulty whether the habits of fish, under the exceptional circumstances in which it was placed in confinement, are the same as those of fish in a natural state. It is never safe to rely too much on the habits of animals in an altered condition from that in which they find themselves in a wild state, as reliable evidence of the habits of animals in their natural state. They may serve to indicate the course to which observations should be directed; they cannot be relied upon further. Indeed, the Usk fish diminished in weight in salt water. There is a popular idea, I do not know on what based, that one of the things Salmon are fondest of as an article of diet are what are known as sea-mice. I have tried, and vainly tried, to ascertain any grounds on which the assertion rests; a Salmon may very likely feed upon them, but whether it does or not rests upon that most unreliable authority, the unsupported testimony of fishermen.

On the Usk there is a saying, "A good year of prides (lamperns), a good year of Salmon." I believe that this is borne out by observation. Thus 1879 was good for both, but whether the conditions to produce a good year are the same for both I cannot say. There is one bit of evidence as to the food of

Salmon connected with lampreys; the young lampreys migrate seawards in September, October, and November, and a Salmon will sometimes greedily take a young lamprey as a bait,—the dark back and the bright silvery belly make the bait show well in the water. It may be that the Salmon mistakes it for an elver, or it may be that lampreys form part of the food of Salmon. In support of what I have said about Salmon feeding at night, it may be urged that both lampreys and elvers run mainly at night. I have been told, but I have never seen it, that *clean* Salmon are sometimes taken both with a live bait on a trimmer, and with a dead gorge. If this is so, there would be some evidence to show that a Salmon does feed on fresh-water fish.

Many anglers will bear testimony to the fact that clean Salmon are caught spinning with a natural or artificial bait. This, again, is evidence to show that Salmon take fresh-water fish. Indeed, I presume no one would deny that such was the case; all that would be said in reply would be that these are exceptional and occasional cases, and that while it is quite true they may happen, yet the fact remains that, as a rule, the Salmon does not habitually feed in fresh water. It is this last point on which evidence is required. Is the Salmon an habitual or only an occasional feeder in fresh water?

Another point, which is of more practical importance than it appears at first sight, is at what rate of speed do Salmon swim? Here, again, there is no distinct evidence, but the answer is usually ob-

tained in this way. Salmon are caught some way up a river with sea-lice adhering to them. Sea-lice never live more than a very limited time in fresh water; therefore, that Salmon can only have been so many hours in fresh water; therefore, he must have left the sea only so long ago, and, as the sea is a given distance off, he must have travelled that distance in so many hours, so he swam at the rate of so many miles an hour; therefore, a migratory Salmon swims at so many miles an hour. This is one of the cases when, if the premises are only conceded, everything can be proved. But it is by no means clear that the parasites that are found on the Salmon are sea-lice; ignorant observers and fishermen call all parasites sea-lice, and, before anything can be inferred from the fact of the parasites being on the fish, it must be clearly proved that the parasites are sea-lice. It is on this point that the evidence is usually incomplete. No one thinks of keeping the parasites, and the fact of their being sea-lice is assumed. Even assuming they are sea-lice, is it clear that they will live only a very limited time in fresh water? They will only live a very short time if plunged directly into fresh water, but that does not prove that that is the time they will live on a fish who is working his way gradually from salt to fresh water. On this point, far more evidence than now exists would be required to prove as a matter of fact how long sea-lice on a Salmon will live. If these two conditions are unreliable, the test is also unreliable; it may be some evidence from which an inference

may be drawn, but that is all that can be said for it. I must confess that I consider the rate of speed a Salmon is supposed to travel greatly overrated. Granted, that a fish when hooked goes off at a great pace, and also darts away when alarmed at a high rate of speed; yet neither of these furnish any criterion of the real pace of the fish, any more than the rate of progression of a person startled, or trying to avoid an accident, would furnish a criterion of his usual pace. The fish swim up with the tide, and, I believe, go a long way with it, and the pace seems regulated by the tide, for one sees fish on the flood tide as it runs up, going up with the tide, but hardly ever in advance of the tide. If, in default of better evidence, one assumes that the fish, as far as the tide runs up, swim with the tide and about the same pace, it would not, so far as one can judge, be very wrong. But when they get to fresh water their pace falls off. They have no longer the stream to take them, but are swimming against it. The exertion of getting up a weir or a rapid is considerable, and the fish rests after it. That this is so is clear, as on several rivers the best draft for nets is not below but *above* the weirs, the fish, being tired passing the weir, rest in the dead water above. I know an instance where a man declined to put in a fish-pass under the Act of 1861, which only prohibited netting *below* a weir if no fish-pass existed, on the ground that he did not care to net the weir-pool. But when the Act of 1873 came into force, and fishing was prohibited both above and below

unless there was a fish-pass, the gentleman at once put one in, saying he could not afford to give up the draft above the weir.

Again, unless in a fresh, Salmon do not travel much in the day-time. Those who remember the controversy raised as to the Wye bye-laws, that sought to prohibit night-netting in the middle-water of the Wye, and the evidence then given, will fully agree with this. The lessees and owners there contended if they could not net at night the fisheries would be ruined, and all the Salmon would pass them. Of course, Salmon do pass upwards in the day, but I incline to think night is the time at which the majority go. I have once or twice had an opportunity of seeing Salmon pass up a stream in the autumn. They did not (at least, those I saw did not) swim at any great rate, but kept steadily swimming on, certainly not faster, if so fast, as a man would ordinarily walk. This is confirmed by the following extract from a letter from Mr. Wrighton, quoted in the Usk Report for 1873:—

"On Monday, September 26, about 12 o'clock, as I sat on the bridge at Newbridge, I observed seven botchers (grilse) very near together, and I judged them to be fish of from 5 lb. to about 7 lb. (two of the latter weight). After a lapse of three or four minutes, they pushed on under the archway, into the Bridge Pool. Almost immediately afterwards, four other fish, of about the same weight, arrived at the place where I had first seen the previous lot; they rested for a few minutes, and then passed on. The

tide was out at the time, but had been up as high as the upper sign in the morning, high-water about 6 a.m. All the fish referred to were bright and clean, evidently fresh arrivals, and I am certain there had been, for some 48 hours previously, a very considerable run of fish, chiefly (botchers) grilse. I had been on the river almost continuously for several days in succession after the *last* fresh, and for the first time this season, for two or three days, the lower water was very bare of fish. This was especially noticeable, because, notwithstanding the high water that has prevailed all this year, after each rise there has been abundance of fresh fish; but all at once I found numbers had come up, and was unfortunate in losing four the day I saw the fish at Newbridge, and three on the previous Saturday, all small. In former seasons, after a succession of freshes, the lower water has usually been almost without fish for several days at this time of the year; but this season the run has been almost continuous from the beginning, and there must be far more fish in the upper water than ever previously. Certainly, since I have known the river (some 17 years), I never remember so many botchers running so late before. I usually look for the very largest Salmon to come up, with the river at its height of the past fortnight, and am satisfied some very heavy fish must be up shortly. There have always been some fine botchers, I think, coming up, even at the end of the season."

This testimony is interesting, as showing how the Salmon proceed on their migration; they seem to

swim up leisurely, at no great pace. The question is, therefore, not how fast *can* the Salmon swim, but how fast *does* he swim? and I very much doubt if, taking everything into account, when actually travelling, he travels at the rate of more than from two to three miles an hour. If so, and allowing 12 hours out of the 24 for travelling, 36 miles in the 24 hours would be the outside rate of progress.[1] A Salmon would therefore take, as the Severn is 158 miles long, if he had a clear run, at least a week to reach Montgomeryshire.

The present weekly close-time is 42 hours, and it is supposed to have for its object to allow the fish to reach the upper waters. It may be said with confidence, that for this purpose, the present, or any weekly close-time, is a delusion.

The rate above given as the rate at which Salmon travel, is confirmed by this fact: Worcester is about 30 miles above Gloucester; Newnham about 16 miles below Gloucester. The tide usually compels the lower fishermen to leave off fishing early on Saturday morning, the result would be that the fish in the tideway between Newnham and Gloucester would, if

[1] In a French work, "Deux Ans de Navigation et Exploration de l'Amiral Chéritoff sur la corvette le *Saint Nicholas*, par H. Marguerit," there is the following statement as to the pace at which salmon swim: "La vitesse de la course est prodigieuse dans les lacs ou dans les eaux calmes. Il peut franchir en une heur un distance de 40 à 50 kilomètres, c'est à dire, 10 à 12 lieues" (p. 12). It would be interesting to know the evidence upon which this "prodigious" statement rests that a salmon travels at the rate of an express train.

they were moving, reach Worcester about Monday morning. This is what usually happens. A number of fish have, by the operation of the weekly close-time, arrived, to be caught by the Worcester nets on Monday morning. For the Worcestershire fishermen nothing could be better, but it may be doubted if this is what the legislature intended when it enacted weekly close-time.

The whole question of weekly close-time is one that requires very serious consideration. On a short river, of not exceeding 50 miles, it would give a free run for the fish, and if there was water, bring them up; but on a long river it will not do that, and cannot do more than benefit the middle nets at the expense of the lower fishermen, while the upper proprietors, for whose benefit it was intended, get nothing. No change should, however, be made, until some reliable evidence is obtained of the pace at which Salmon swim. This is another case where the best information will be obtained by marking the fish.

The subject of disease is so obscure, that I hardly venture to say anything on it. All I can do is to give the Severn experience. For years, as long as any records have been kept, every season a certain number of Salmon are found dead after spawning, and most of these fish are diseased. Some years it is worse than others. The winter of 1870–71 was a bad one; 136 of the fish found dead were diseased. It is always more virulent after a severe winter than after a mild one. Fish other than Salmon are often affected with it to

a certain extent. In 1883, the first instance of a diseased Salmon, other than at the spawning-time, was recorded. A clean fish, badly diseased, was taken in the estuary in the spring. In 1884 the disease appeared in the Verniew, a tributary of the Severn, in clean fish; and one or two clean fish diseased were caught near Worcester; it then disappeared. The above are, I believe, the instances of disease in the Severn; but it should be added that, in the year 1885, during the summer, the roach and dace in the upper water, but especially the roach, seem to be affected with it to a considerable extent; but no instance of a Salmon so affected was reported. The following curious instance of how the infection remains is perhaps worth mentioning. I had a number of fish in a well-boat fastened across the river, through which a stream of fresh water was constantly flowing. The boat was a new one, and, as it had not been sufficiently seasoned, the new oak killed the fish; they were thrown away. A little time after some more were put in, and one or two of them, a few days after, showed signs of the disease. I had them taken out and buried, and ordered the boat not to be used. About a month after, a good many fish had been caught, and the man complained he was short of room for the fish. I went down to look at them, and saw in one lot several diseased. On being questioned, the man admitted that these fish had been put in the boat that had had diseased fish in it, that I had ordered not to be used. The

boat was then taken away. In the winter, being very pressed for room for eels, a number were put in, with no bad effect; and the boat was used through the winter without anything being noticed. The next autumn some eels were put in; one had a small wound on its tail, and at once on this the disease appeared. During the whole time there was water flowing out through the boat. I do not pretend to offer any explanation of this; I can only record the facts; but it seems to show that the disease may remain a long time in the water until a fit subject for it is introduced. I ought to add, that I did not examine the fungus with the microscope, and so am not able positively to say, although I believe it to be the case, that the disease was Saprolegnia ferax.

One other point as to the disease: does it, after a few years, decrease in virulence, or do the fish become acclimatised to it? The Usk experience for 1885 is very peculiar. In the winter there was less disease than usual; in the late spring it was worse than usual, and lasted longer than it ever did before; but the mortality was small; most of the fish recovered; many were taken with the old marks on them, but healed over. This seems to point to the fact that in the first year the disease is more deadly than afterwards.

A point that is deserving of notice is the presence or absence of migratory trout in rivers. It is difficult to account for this, especially in rivers that fall into

the same estuary. In the Usk, migratory trout,—I use the expression on purpose, not to have to distinguish between bull-trout, sewin, peal, &c.,—are plentiful, and some run to a large size. I believe a few are found on the Wye. In the Severn only a very few are caught, and these small. Westward from the Usk the migratory trout are common in the rivers. Perhaps a more remarkable instance is the Teifi, one of the rivers that flow into Cardigan Bay. On each side of it migratory trout are found; in it they are not. Can any explanation be given of this? As to the migratory trout, observations on their habits are important, as tending to throw light, directly or by contrast, on the habits of other Salmonidæ. In the Usk, the large migratory trout usually come first, about June, and the smaller ones later. A clean-run sewin of three-quarters of a pound was taken in the Usk on April 29, 1873, which is noted as exceptionally early. In the autumn of the year, a number of small sewin run up the Usk; they are clean-run fish, and not in a condition to spawn the same winter; they are not barren, as the roe and milt are perfect, but not developed in the manner usual at that season. The earliest date that sewin have been noticed spawning on the Usk seems to be September 27, 1873, and October 1, 1873. What are these clean-run sewin? Do they stay in the river a whole year, or do they return to the sea, spawn, and ascend again? On December 7, 1871, three clean-run sewin were caught in a net near Usk. In June,

1870, a bull-trout kelt was taken in the Usk. What were these fish? Looking at the fact that the migratory trout spawn earlier than the Salmon, does that give any explanation of the reason that in sea-trout rivers the sea-trout increase in larger numbers than the Salmon?

In the Severn the migratory trout appear at the end of the summer and early autumn; they are nearly all small, seldom exceeding 1 lb.; but I have no evidence as to when they spawn. On the Forth, I am told, there are four distinct runs of migratory trout in a year.

"1. Those known as Lammas men, herlings, or skirlings. They appear in January, and again in August; they are neat little fish, like the young Salmon; they are from 6 oz. to 12 oz. in weight, and lively on the line.

"2. Sea trout, very green and silvery; very smart little fish; seldom caught with the fly, but often with the minnow; run from 2 lb. to 5 lb.; appear first in February.

"3. Two distinctly-marked trout; one has spots all over its body, the other only below the line; one quite pale, the other quite red as to flesh; they run from 1½ lb. to 2 lb. in weight; are found in May, and continue till August.

"4. Are called Salmon or bull-trout; a strong, coarse-looking fish, rather dark in the scales; they are first seen in July, 4 lb. to 10 lb. in weight, and have been got 16 lb."

From this description of the migratory trout on the Forth, it is obvious that various different kinds of fish are included. It would be interesting to know how far in the English rivers the runs of the different migratory trout correspond with them. On the Usk, the migratory trout run to a large size. In the winter of 1871-72, one of 49 inches in length was thrown up dead; the pyloric appendages were 48 in number. On January 3, 1870, a bull-trout kelt of 15 or 16 lb. was taken in a net near Usk; on January 11, 1873, a bull-trout of 28 lb. was caught; and on April 4, 1876, one of 20 lb. was caught in a putcher at Goldcliff. It would be very interesting if further information could be got as to the time of spawning and habits of these migratory trout, especially as to the clean sewin in the autumn. Do these fish remain in the river till they spawn, or do they return to the sea without spawning? Do they feed in the river, and if so, on what? Do they increase in weight while they remain in the river? All these questions would be important in considering the like questions as to Salmon.

There is one very interesting point as to migratory trout that furnishes much information. I mean the experience of the Coquet. Years ago that river, it appears, was a salmon river, and an attempt was made, in the four years 1868 to 1872, to kill down the bull-trout, and restore the Salmon. The attempt failed, and was discontinued after 1872; but during its continuance the annual close-time was suspended,

and the fishing carried on throughout the year, and by this means some facts were arrived at as to the time the trout frequent the river. The figures are interesting.[1]

	Open season. Feb. 1 to Aug. 31.	Close season. Sept. 1 to Dec. 31.	Total.
1868.	1,757	26,350	28,107
1869.	1,747	15,464	17,211
1870.	770	10,687	11,457
1871.	4,434	9,188	13,622

It thus proves that, so far as migratory trout are concerned, 1, the fish caught in the open season are no index to the fish that frequent the river in the close season; 2, the trout do not run in great numbers until the autumn; and 3, it shows how very rapidly killing fish during close-time tells on the quantity of fish in a river. As far as it goes it seems to point out how fatal an extension of the open season is on the stock of fish.

There is a fish known in the Usk as a sewin-pink. What are these fish? Are they the young of the sewin, or hybrids between the sewin and some other Salmonoid. They are larger fish than Salmon-pink, and if they are the young of the sewin only, it seems strange that the young of what on the average are the smaller fish, the sewin, should be larger than the young of what on the average are the larger fish, the

[1] Fourteenth Report, p. 112.

Salmon. Without in any way giving an opinion on the question—for I have not grounds to enable me to do so—it seems to me that there is some reason to infer that these fish are hybrids; and, for this reason, in the upper Teme a number of very large parr, or fish that resemble smolts, can be taken. Some doubt existed as to what these fish were, and some were taken and submitted to Dr. Gunther; he at once said they were hybrids. These fish, although not identical, bear a very close resemblance to sewin-pink.

It appears from the Usk reports, that it is probable that many of the smaller fish on the Usk are hybrids between Salmon and trout. In November, 1876, in one of the Usk tributaries, a male grilse, of some 5 or 6 lb., was seen spawning with a female trout of 1 lb., and the same thing had been observed in a previous year. This would seem to establish that hybrids between trout and Salmon exist. The evidence from the Teme goes to show that the hybrid parr are large fish. Are sewin-pink hybrids, and if so, between what fish?

The questions that require to be answered as to Salmon food, are:—

1. On what do Salmon feed? (*a*). In the sea. (*b*). In the estuary. (*c*). In the fresh water.

2. Do Salmon lose or gain in weight, or remain stationary while in fresh water?

3. Do Salmon feed habitually, or only occasionally, while in fresh water?

II. As to the speed at which Salmon swim.

4. At what rate of speed do Salmon swim up a river?

5. Is there any difference in the rate of speed in a fish ascending in the summer, and fish ascending in the winter?

6. On what grounds is the calculation as to the rate of speed formed?

III. As to migratory trout.

7. What different kinds of migratory trout frequent the rivers?

8. At what time of the year do the different kinds chiefly run?

9. Do clean-run migratory trout spawn the same year as they ascend the river, or not?

10. If not, do they remain in the river until they spawn, or migrate again to the sea?

11. At what time of the year do migratory trout spawn?

12. Do the migratory trout feed in fresh water; if so, on what?

13. Do migratory trout increase or decrease in weight while in fresh water?

14. What are the largest instances of the different kinds of migratory trout recorded?

15. What are sewin pink?

16. Are there any, and if so, what hybrids between different and what kinds of Salmonidæ found in the rivers?

17. Do such hybrids breed, and do they migrate, and if so, at what time of the year?

CHAPTER X.

CONCLUSIONS.

HAVING stated some of the questions that require to be answered in order to obtain a more satisfactory knowledge of the Salmon, its habits and history, it remains to point out how the observations to obtain the information necessary to answer such questions can best be procured. As has been already stated, the authority who ought to take the matter up is the Inspector of Fisheries; he could compel each Board to give information, and although it might not be all of equal value, yet a good deal might be learned, if only from a perusal of the journals of the 237 water-bailiffs employed in England and Wales. As, however, all the Inspector does is to suggest that the Fishery Boards and others should do his work, and institute careful observations, it remains to consider how this work can best be done. Certain observations and experiments should be only carried out by Boards of Conservators, not by private individuals; the chief of these is marking fish. If this was done systematically for a few years, I believe great results would follow. In 1873, at the request of the then Inspectors, marking was tried on a very small scale, but no results followed, as the fish

that were marked were too few. Some such scheme as the following is what I want to see carried out. In the beginning of September, fish for, say, a week in the lower part of the Severn estuary, where the Wye and Severn districts join; mark every fish caught. A short time afterwards, when a run of fish was observed, fish again, and mark all fish caught; and on the next run, fish again, and mark the fish. On the first run of fish to the spawning-grounds, net them, and see if any, and what number, of the marked fish have run up; record all the marked fish, weight, condition; re-mark those that have been marked and mark all the others, and repeat this at each run of spawning-fish in the upper water. Let all kelts that are caught, and all fish that it is possible, be marked. This would probably give some such result as this. Assume 500 fish marked in the estuary, a certain number of these fish would be found spawning, and this would give some indication of where each run of fish went, what river they frequented, and in what condition they arrived: how they had altered in the time between which they had been taken the first and second time. If these fish were again re-marked, then their subsequent capture on their way to the sea, or as well-mended kelts, or in the estuary, would give us some data as to the migration of kelts. If they were not caught until after they had been to the sea, then we should get some information as to the return of fish from the sea, and the condition in which they returned. I know nothing that would be

more likely to increase our knowledge of the habits of Salmon than a series of well-regulated markings, undertaken by some competent authority, and continued for a series of years.

It will not be necessary to go into further details here: these, of course, will require careful working-out, and might also have to be adapted to each river; but a uniform system of marking must lead to important results. I shall be told that this was tried in 1874 by the Severn and Wye and Usk Boards, and nothing came of it. This is true; but the experiment was tried on so small a scale, and in a very unmethodical way, only such fish as might be caught accidentally, or otherwise, were marked; there was no systematic fishing for fish for the purpose of marking them, and the number that were marked was so small (on the Severn not 200) that any results could hardly be expected. The marking must be carried out in a proper systematic manner each year. I am convinced it is only by some such mode as this that any satisfactory explanation of the questions now waiting solution can be obtained. Buckland urged this strongly. He says:[1] "I would urge the Boards to take every possible opportunity of marking the descending kelts; a cut with scissors, or a hole punched in the adipose fin, is a better mode of marking than by placing any foreign body, such as a piece of wire or a label, on any part of the fish." If

[1] Fourteenth Report, p. 65.

this is so, the usefulness of marking is gone, because you cannot brand, if you brand at all largely, so as to be able to identify the fish. There are two great difficulties in the way of carrying out this system, the first is money. Fishing and marking the fish in an extensive way would cost at least £100 a year, and there is hardly any Fishery Board that could afford to expend £100 a year in scientific experiments, even if they legally could. The second is a legal difficulty. As the law now stands it is very doubtful if Boards of Conservators would have the power legally to fish for Salmon during the close-time in the way proposed; if they had, then another difficulty would follow, they could only so fish in public water, and very likely the places where the experiment should be carried out would be private water. All the upper waters are in private hands, and the Board would have to get the consent of the various owners before they could net.

I am afraid Fishery Boards are not popular with upper proprietors, and I feel sure of this, that while the large landowners would gladly help the Board, and allow experiments to be made, the small owners would not, but would delight in showing their power by preventing the Board netting where perhaps it was all important they should do so. I am not speaking without experience; on a stream in the Severn district all the banks, except about three fields, belong to two large landowners, members of the legislature; both of these give every facility to the Board and water-

bailiffs to traverse the banks of the stream at all times; the three fields belong to two small owners, who will not give permission because they dislike the Board, and if it was not for the power given by the 1873 Act,[1] to enable water-bailiffs to traverse land with a warrant signed by the Chairman of the Board, the bailiffs would not be able to go on that land. As it is, all the landowners do by their obstructions is to make me sign my name to warrants every two months; but of this I feel sure, if the Board wanted to net on the lands of either of these owners it would have no chance of getting permission. It will, therefore, be necessary to get a short Act of Parliament, giving Boards of Conservators power either to join with other Boards, or alone to carry out such experiments, to pay for the same out of the revenue, and for the purpose of such experiments to fish at such times, and in such places, and in such ways, as may be necessary, without being prosecuted as trespassers, or for illegal fishing.

This, at first sight, seems rather a strong measure, but it is nothing compared with what is contained in the Sea Fisheries Scotland Act just passed into law,[2] the 4th Section of which provides, "When it appears to the Fishery Board for Scotland desirable to make any experiments or observations with the view of ascertaining if any particular mode of fishing is injurious, or for the purpose of fish-culture or

[1] Sec. 37.

[2] 48 and 49 Vict., c. 70.

experiments in fish-culture, the Fishery Board may make bye-laws for restricting or prohibiting either entirely, or subject to such regulations as may be provided by the bye-laws, any method of fishing for sea-fish during such time or times as they may think fit." A much more limited power would do all that was required for marking fish, and no possible injury could be done to any one. Any necessary provisions for the protection of the proprietors of the land might be inserted in the Bill.

The second mode by which Fishery Boards can help to advance our knowledge of Salmon is by artificial breeding. This has become a very favourite and fashionable amusement, but the way it is carried out does not do much to advance science. The usual thing is to buy so many thousand ova, hatch them out, and turn them into the stream; of course, by adding so much stock to the river, that does good, but the amount of good done is very small. Others try all sorts of experiments in hybridising fish—very interesting, but not of great practical value. While a third try to breed foreign fish of various kinds, which they threaten to turn into the river, and, if they did so, very great mischief might easily be done. The artificial breeding I advocate is on a different footing. If I am right in the conclusion that the bulk of the Salmon ova spawned after the end of January comes to nothing, from being deposited on unsuitable places, the one object of the Board should be to collect such ova and endeavour

to hatch it out. This would be clear gain to the river. What I venture to propose is that a fish-breeding establishment should be formed for each district, or for united districts; that all ova that is likely to be lost from being deposited in unsuitable places be taken from the fish and hatched out artificially; that the fry be fed and kept in pools until they arrive at the smolt stage, and then liberated; in fact, establish a sort of Stormontfield for every district. Mr. Buckland proposed something of the kind as far back as 1875, when he proposed that the Boards should take means to deprive poachers of any wholesale capture of fish on the spawning-beds, and hatch out the eggs.[1] I should propose to establish the breeding-places as near the estuary as possible, so that the smolts might avoid all the dangers they now meet with on the way to the sea, and so that the largest possible quantity of smolts might annually reach the salt water. If this could be done to a large extent, it is possible that one may find a partial solution of some of the difficulties that now beset Salmon preservation. If you could reckon on turning so many million smolts annually into the estuary, the capture of smolts by anglers would not be of such great importance as now, for to some extent the fish-supply would not solely depend on the smolts that migrated from the upper waters, but also on the smolts artificially bred. If this is to be attempted, it must be

[1] Fourteenth Report, p. 62.

done on a very large scale. Breeding a few thousands a year would be useless; the quantity must be millions, and it is only by breeding the largest possible quantity that any appreciable result could be obtained. Of course, the cost would be considerable, and I am by no means clear how far it is practicable to carry on artificial breeding on such a scale. To give some idea of what I mean, Mr. Buckland was a great fish-breeder. In his Report for 1878, he says he has received and distributed 1,186,000 eggs of Salmonidæ.[1] A breeding-establishment to do any good should hatch 2,000,000 eggs a year. These figures are so large that I fear they will frighten people. Still, I am most desirous to try and make an attempt to utilise what is now lost. As far as it could be done, I should like all artificially-bred fish to be marked. I know nothing that would help more to enlighten us on Salmon history than this; but when one considers what marking even 1,000 fish means, one shudders at the idea, and feels extremely doubtful if it is in the bounds of possibility to mark on such a large scale as I spoke of breeding. In addition to the regular breeding-places, there should be an experimental breeding-place to try and solve such questions as,—by what means are parr brought quickest to smolts? Do grilse breed such strong fish as Salmon? Do crosses of grilse and Salmon breed better smolts than either grilse or Salmon alone? and a number of

[1] Page 37.

other questions that will speedily arise. What one wants to find out is, how can the largest and best quantity of food be soonest produced? As a cattle-breeder tries Shorthorns and Herefords, and finds out at once their milk and beef-producing qualities, and which he should breed from, and how he should cross, as he wants an animal for a specific purpose, so we want to know as to Salmon, and by experiments with artificial breeding obtain some help to solve these questions. At present we know next to nothing. We look upon Salmon as Salmon. The cost of such an establishment as I have mentioned would be considerable, and I know no Board who could afford it; but while it may be impossible to do all one wants, a start on a small scale might be made. At present we are doing nothing; anything is better than that. If a start was made, either Government, which now gives a grant to the Scotch Fishery Board, or some Scientific Association, or some other source, might be found to subsidise and help to bear the cost. Probably here also some legislation is required to give Fishery Boards power to carry out such a task as I have suggested. For when, twenty years ago, Fishery Boards were formed, it never entered into the minds of the legislature that any such duties would devolve on Fishery Boards, and so no power was given. It is to artificial breeding and marking I look as the means of increasing our knowledge of the habits of the Salmonidæ. One is at once met with the question, "What is the best form of marking fish?" and

it is a very difficult question to solve. When, in 1874 and 1875, some fish were marked, they had a label with a bit of silver wire attached to the dead fin; on one side of the label was a letter showing the river the fish came from: S.—Severn; U.—Usk; W.—Wye; on the other a number, and a record corresponding to the number was kept of the time and place the fish was marked.

This course was adopted after a good deal of consideration, and I do not see how it can be much improved. At one time I was rather inclined to brand on the cheek, but I am not clear if the mark would not wear out. What is wanted is some mark that cannot be effaced or put on by either interested persons or practical jokers, and that will not in any way affect the fish, or interfere with its development. Any suggestion as to the best modes of marking I shall be thankful for. Cutting off fins, entirely or partially, are all objectionable, for one never knows how far any mutilation may affect the fish. A Circular, a copy of which will be found in the Appendix, was issued as to marked fish, in 1874.[1] The objection to labels is this: if the label can be transferred from one fish to another, there is always danger of persons doing this to get the reward.

Individuals, as well as Boards, can help in the work. Our knowledge of Salmon may be increased by any person who has the opportunity of taking accurate

[1] The Circular is Appendix III., p. 209.

notes of what they may see. A gentleman, staying for a fortnight's holiday at a place on the Severn, once sent me some very valuable notes as to what he had seen in regard to some elvers that were ascending the stream. They always came at a different time of the day, and took a particular course. He inquired, and found that the time was regulated by the tide lower down; the course was, most likely, by a stream that came in a little further down the river. No one but himself had ever noticed this. All observations made by a reliable person on fish and their habits are valuable, and help to solve the different questions that are waiting solution. I believe that the worst persons to go to, if knowledge of fish is required, are fishermen. They, as a rule, know very little, and they supplement their ignorance by mendacity, the measure of the mendacity being the amount the inquirer will swallow. They always tell you things used to be better than they are now and that something or other is ruining them. They know how to catch the fish, but only by a rule of thumb. A more obstinate, opinionated set of men it is impossible to find. They will give no information as to the habits of fish, and they decline to answer any questions as to the take of fish, and if you rely on their information you always find that any conclusions you draw are utterly wrong. Next to the fishermen, the worst people to go to are those who know a little, and then set up a theory, and ignore everything that conflicts with this theory. By con-

sistently pressing their theory before the public they get people to believe it, when it may be, and very often is, most opposed to all the real habits of fish-life. Then come the owners of fisheries, who simply look at the question from the one point of view, "What will increase my take of fish? Never mind the river, and what is best for it generally, but what is best for me personally?" When Parliament legislates on Salmon fisheries—and it is always doing it—a Select Committee is appointed to inquire into the fishery laws, and fishermen, theorists, and owners are examined before it. On their evidence a Report is made, and on the lines of it legislation follows. People wonder that the legislation does not do more for the fisheries. The wonder is that it has done so much, when it is based on ignorance of the habits of the fish. It is to be devoutly hoped that, until some exact knowledge as to fish and their habits is obtained, Parliament will not give us any more fishery legislation. Of course, there are points in the different Acts that require amendment to make them work smoothly—I could mention a number—but it is better to put up with these, and wait until we know more of the habits of Salmon before we alter the laws, or try more legislative experiments. The present Inspector recommends observations to be made, and no advice could be sounder; but, unfortunately, he does nothing to help to get those observations made. If only to his queries he would add some as to the different times the Salmon enter

the rivers, when the large fish come, when is the great run of fish, &c., some information might be obtained; but we have nothing of the kind. I have ventured in these pages to state some of the points it seems to me we want to know. I am quite prepared for the remark that "fools ask questions wise men cannot answer"; I am fully sensible that my knowledge, or ignorance, is mainly drawn from one river; I am quite aware that I have left out many important matters. Of the questions I have asked, some persons will give an answer off-hand, and deplore my ignorance in asking them. I could give plausible, theoretical, or inferential answers to almost all; but I want some facts, to be able to give a real answer, and if any one who favours me by reading these pages will give me any information he has collected I shall be most grateful. The Salmon is the most important fish we have. There is no modern history of the Salmon worthy the name. I have neither time nor opportunity to attempt to write such a history, but I am desirous of collecting such information as I can. If lessees of fisheries would only note whether they catch more male than female fish, what per-centage of grilse to gillings, of gillings to Salmon, when the large fish run, what number of runs of fish there are in a season—they would be giving important information, and by no means disclose their trade secrets, or run the risk of having their rent raised. If residents on rivers would

note when they first and last saw the fish at the weirs, when they saw smolts descending the stream, when they saw the fish spawning, it would also help to answer the questions. If fishmongers would say in what condition they got the fish, the size of the roe and the milt, the per-centage of males to females, all would be valuable aid. Perhaps some may feel inclined to do this, and if they do, I will gladly say exactly what it is they are to look for, and how they are to note it.

I have confined what I have said to observations that any one may make; but there are some that are, perhaps, still more important, as to weather, temperature, water. These I have purposely abstained from mentioning now, for, if this book excites sufficient interest to justify another series of "Salmon Problems," they will more fittingly form such a series; and, if these were stated here, they would make the book far too long—although, I am afraid, it is that already—and rather deter than attract observers as to the Salmon and its habits.

APPENDIX.

I. Letter of the Inspectors of Fisheries to the Usk Fishery Board, dated November 22, 1871.

II. Extracts from the Reports of the Usk Fishery Board, as to the Usk Salmon in the Brighton Aquarium.

III. Circular Letter of the Usk Board as to marked Salmon.

APPENDIX.

I. *Letter addressed by the Inspectors of Fisheries to the Chairman of the Usk Fishery Board.*

SALMON FISHERIES OFFICE,
4, OLD PALACE YARD, WESTMINSTER, S.W.,
November 22, 1871.

SIR,—We have the honour to inform you that, as it appears to us that exceptional opportunities exist in the river Usk for ascertaining certain points connected with the history of migratory Salmonidæ—on which point no definite information exists at the present moment,—we think that it would tend to results of practical advantage if the Conservators of the Usk would allow experiments to be made, with a view to clearing up the points about which there is now much uncertainty.

It seems to us that the points on which information is chiefly required are:—

1st. The condition of Salmonidæ at different periods of the year.

2nd. The time at which the heaviest and the lightest fish enter our rivers, and the conditions of

temperature, or otherwise, favourable or adverse to their migration.

3rd. The proportion of males to females, and the proportionate weight of ova and milt to the fish themselves.

4th. The increase or decrease of bull-trout, and other migratory Salmonidæ, compared with the Salmon proper.

These facts might probably be ascertained, if the Conservators would allow experimental netting to be conducted in the river Usk, at stated intervals of the year, with a small-meshed net; and the results of these experiments might be summarised in Tables similar to those we now enclose.

We presume that if the Conservators should not object to these experiments being made, they are so obviously in conformity with the intention of the 60th Section of the Salmon Fishery Act, 1865, that no technical exception would be likely to be taken to their being at once instituted.

We have the honour to be, Sir, your obedient servants,

FRANK BUCKLAND,
S. WALPOLE,
Inspectors of Salmon Fisheries

A. D. BERRINGTON, ESQ.

II. *Reports on a Salmon from the Usk in the Brighton Aquarium.*

The following extracts from the Usk Reports relate to the Salmon from the Usk that lived for four years at the Brighton Aquarium (Report for 1873).

"The managers of the Brighton Aquarium, an institution which promises to afford most valuable opportunities for studying the natural history of fish, and by which considerable contributions to science have already been made, having consented to make experiments with reference to the development of Salmon, Mr. Berrington, on April 5, 1873, sent three kelts and thirteen Salmon-pink from the Usk to Brighton. The fish were all conveyed in safety, the Great Western Railway Company having been good enough to make special arrangements for their transit; but the fresh water at the Aquarium, which is obtained from a deep well in the chalk, proved deleterious to them, and the kelts all died. Of the Salmon-pink, on May 14, only five survived. These were still in fresh water; their smolt-scales were perfect; and they had evidently long passed their time for going to the sea. In consequence of previous observations, Mr. Berrington advised that they

should immediately be transferred to undiluted sea-water. Each fish, when dropped into the salt water, gave three little sobs, as if the dose was rather strong, coursed rapidly once round the tank, and then settled into his ordinary habits. In another hour they were feeding, and appeared none the worse for the change. Of the five pinks, three were lost by accidents, but two remained to carry the experiment to a successful issue. By the kindness of Mr. Lee, we have received the following communication, under date December 29, 1873:—'I am very glad to be able to tell you that one of the smolts is alive and thriving, and has grown into a perfect grilse in salt water. It is a small grilse, but is as bright in the scales as silver, and has the appearance of a true Salmon. It feeds voraciously on shrimps, &c. The other throve just as well, but about a fortnight ago it leaped out of the water on to a dry ledge of rock, and was found dead one morning. Both of these smolts have, on different occasions, leaped out of their own tank over a wall eighteen inches broad, and about ten inches high above the surface of the water, into the tank next to theirs—one to the east and the other westward. Mr. Buckland lectured at the Aquarium on Friday, the 19th inst., and then saw the remaining smolt (now grilse), and was delighted with its appearance: you will see that he mentioned it in *Land and Water* of last Saturday. I should be very glad to have some more of these smolts, and I believe we could now keep them with a greater per-centage of success than last

year. I assure you I feel very great interest in them, and I consider that the kindness of the Usk Fishery Board of Conservators has not been thrown away, but that this one living specimen, and its satisfactory growth, is sufficient to repay us all for the care and trouble bestowed on the experiment.'

It is proposed to send up a further supply of Salmon-pink in the spring. Our best thanks are due to the managers of the Aquarium, and especially to Mr. Lee, for the trouble they have taken in this matter, and for their endeavours to throw light on the natural history of Salmon."

The next mention is a letter of Mr. Lee set out in the Report for 1875 :—

"On April 5, 1873, the Board of Conservators of the Usk and Ebbw, on the kind proposal of their Chairman, A. D. Berrington, Esq., sent to the Brighton Aquarium, in charge of their water-bailiff, thirteen Salmon smolts, which had been taken in the Usk on their way to the sea. Nine of these survived the journey, and, as they had unmistakably assumed their smolt scales, were placed in sea water—three of them suddenly and directly, and the rest by degrees —by the gradual addition of salt water to fresh.

"It might well be supposed that as the fish must pass from the fresh water of their river through the brackish water of the estuary on their way to the sea, the latter would be the most proper and successful mode of procedure. Somewhat to my

surprise, however, the smolts which were subjected to the sudden translocation prospered best; probably because I had selected the strongest fish for the rougher treatment.

"That they were conscious of the change was apparent by their startled movements, a kind of shivering wriggle of the body, gulping by the mouth, and panting of the gills. These symptoms lasted but for a few seconds, after which the fish appeared to be as comfortable and as much at ease as when in fresh water. I remarked that there was not the slightest indication, even for a single instant, of any variation of the buoyancy of their bodies in the denser medium.

"One after another, seven of these smolts died, until only two remained. These—fed on live shrimps and minced fish—increased in size so rapidly that they might, almost literally, be seen to grow, for every week their progress was clearly perceptible, even in the confinement of a tank, where their circumstances were not, of course, so favourable as they would have been in the open sea. In February they began to show symptoms of uneasiness, and evidently desired to change their abode. One of them, apparently urged by the migratory instinct, leaped out of the water by night, and was found in the morning lying dead on the rock-work above. To prevent a similar casualty occurring to the other, a sprat-net was stretched above the surface of the water, the meshes of which were too small to catch the fish by the

gills in case of its leaping, which it was afterwards seen frequently to do.

"At the end of twelve months after its arrival, namely, in April, 1874, it had become a perfect grilse of, as I judged, about 3 lb. weight. At this period it ceased, for a time, to grow, and the arrest of its development was as marked as the rapidity of its previous enlargement had been. Sometimes excited, sometimes sullen, always restless, it chafed at its imprisonment within narrow limits, and it seemed probable that I should be obliged to comply with its inherent instincts and its longing for change. But as it was the only Salmon of its size that remained to us for observation, I shrank from incurring the risk of interfering with it, even for the purpose of imitating, to the best of my ability, its known natural conditions. Excitement, incautious handling, or the translation from salt to fresh water, might cause the death of so game and sensitive a fish; and, therefore, as it was also desirable to ascertain whether the Salmon can live in the sea for more than a year without ascending a river, I decided to follow that most difficult of all courses when one is anxious, namely, to watch and wait patiently, to abstain from meddling, and to do nothing.

"Our grilse recovered its equanimity in May, and continued to take food sparingly during the summer months; and, although its growth was exceedingly slow, gradually assumed the appearance of a plump little Salmon. If I were writing of a human being

of relatively similar build, I should describe him as a fat, jolly-looking little man, rather stunted in stature, but strong, and in perfect health.

"In September the fish refused food, and by the middle of February (1875) had dwindled so much in size and condition that I gave instructions that everything should be in readiness for its transference to brackish, and subsequently to fresh water. On the 15th of that month I went to Brighton, purposely to superintend its removal, but found that on the previous day it had recommenced to eat heartily of its usual food, and it took in my presence, at one meal, the whole of the flesh of a herring, cut up in small pieces; so I determined to 'let well alone,' and the fish was soon again in good condition.

"In September last (at the same season as in the previous year) it again ceased to feed, and is at present rather thin and 'tucked up.' During the past year it has grown very little, if at all; but, although in poor condition, is not out of health.

"Since the first year, it has not manifested so ardent a desire to leave the sea water, though in April last it was evident, by the abrasion of some of its scales, that it had leaped from the water unseen, and had struck the net extended above the surface to prevent its being injured by its efforts to escape.

"By observations made at the Brighton Aquarium, it is therefore proved—

"1st. That the smolts which go down to the sea weighing 2 oz. or thereabouts, return from their first

migration as grilse or "botchers," of from 4 lb. to 5 lb. weight.

"2nd. That the Salmon can exist for at least three years in the sea, without ascending a river.

"3rd. That (at any rate, from the end of its first to the end of its fourth year) it feeds more heartily, grows more rapidly, and is in better condition at one season of the year than at another.

"Concerning its mode of taking food, I may add that I have never seen a grilse or Salmon seize its prey below the plane of its own position in the water. When shrimps or portions of fish are thrown into the tank, it will rise to meet them as they sink towards it, and, having snatched a chosen morsel, will instantly turn downward with its well-known rush, and, gracefully sweeping round, will mount again for another mouthful. But, although thousands of shrimps may be resting on the gravel at the bottom of the water, it will never notice them, unless accidentally disturbed. These little crustaceans spring upward above the level of its head, or at least in a horizontal line with it, when it will dart at and secure them. A sea-trout, which is in the same tank, will, on the contrary, frequently rummage along the bottom for food, and pick up shrimps and pieces of fish lying there.

"I am unable to account for the slow growth of the Usk fish during the past year. I do not regard it as satisfactorily indicating that the growth of the Salmon during its third and fourth years is less rapid than in its early youth; for it is worthy of note, that

the rate of increase of the smolts which Mr. Hotchkis kindly conveyed to the Brighton Aquarium at so much personal trouble and expense, and which are in the same tank, has been very much less rapid than that of the Usk fish referred to, although they have all been supplied with an equal abundance of food.

"HENRY LEE.

"BRIGHTON AQUARIUM,
"*January* 10, 1876."

The next notice is that in the Report of 1879 of the death of the fish.

"The Usk Salmon in the Brighton Aquarium died in the summer of 1878. It was placed there as a smolt on April 5th, 1873, and in the following month was transferred to salt water, in which it remained for upwards of five years, feeding freely on shrimps, &c., during a portion of the year, but abstaining from food between August and February; this, it may be remarked, is about the time when it would naturally have been in the river. At first it increased fairly in size, but afterwards remained nearly stationary. At its death it was in a very reduced condition, and weighed 5 lb. A further supply of skerling have since been sent from the Usk to the Aquarium. The whole of these, twenty in number, travelled safely to

Brighton in two carboys, unattended, as far as Paddington, except by the guard of the train. The conveyance in this manner of small fish is attended with very little difficulty."

III. *Circular of the Usk Fishery Board as to Marked Salmon.* 1873.

SIR,—At the request of the Inspectors of Fisheries, this Board have caused a silver label, bearing certain marks, to be attached to Salmon which have been taken in the Usk, and returned to the river. Any person taking any fish within the district with the mark allotted by the Inspectors to this or any other district, is requested at once to forward it in the same state as when taken, and with full particulars of date and place of capture, and weight when taken, to the Chairman of the Board—A. D. Berrington, Esq., Pant-y-Goitre, Monmouthshire, Nantyderry Station, Great Western Railway, who, if satisfied with the evidence afforded, will pay a reward of five shillings, in addition to the value of the fish and cost of carriage. The same payment will, in like manner, be made for any fish bearing the Usk mark (the letter U., with a number), and captured beyond the limits of this district, which may be forwarded to the Inspectors of Salmon Fisheries, 4, Old Palace Yard, Westminster, London, or to the Chairman of this Board.

In the case of kelts, they should be returned to the water, and the particulars, together with the number on the label, should be forwarded to the Inspectors, or to the Chairman; but no reward will be given when the fish is not produced with the label attached. Certain alterations will be made on the label each year for the purpose of identification; and the Board will be particularly obliged if gentlemen will assist them in this matter to the utmost of their power, and will make this Circular, of which some spare copies are enclosed, as widely known as possible, it being considered that much information on the natural history of Salmonidæ may be obtained by these means.

I am, Sir, your obedient servant,

CHARLES LYNE, *Secretary.*

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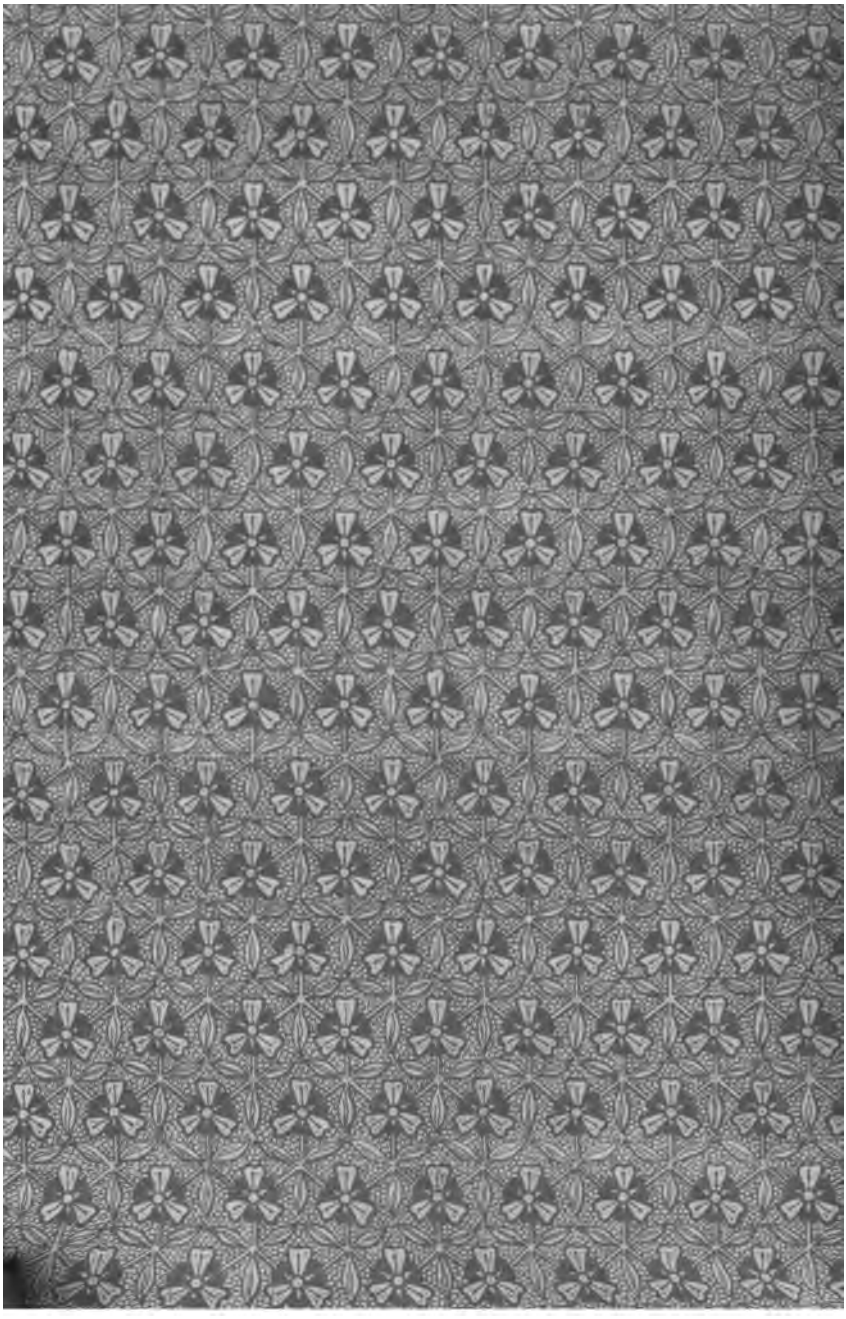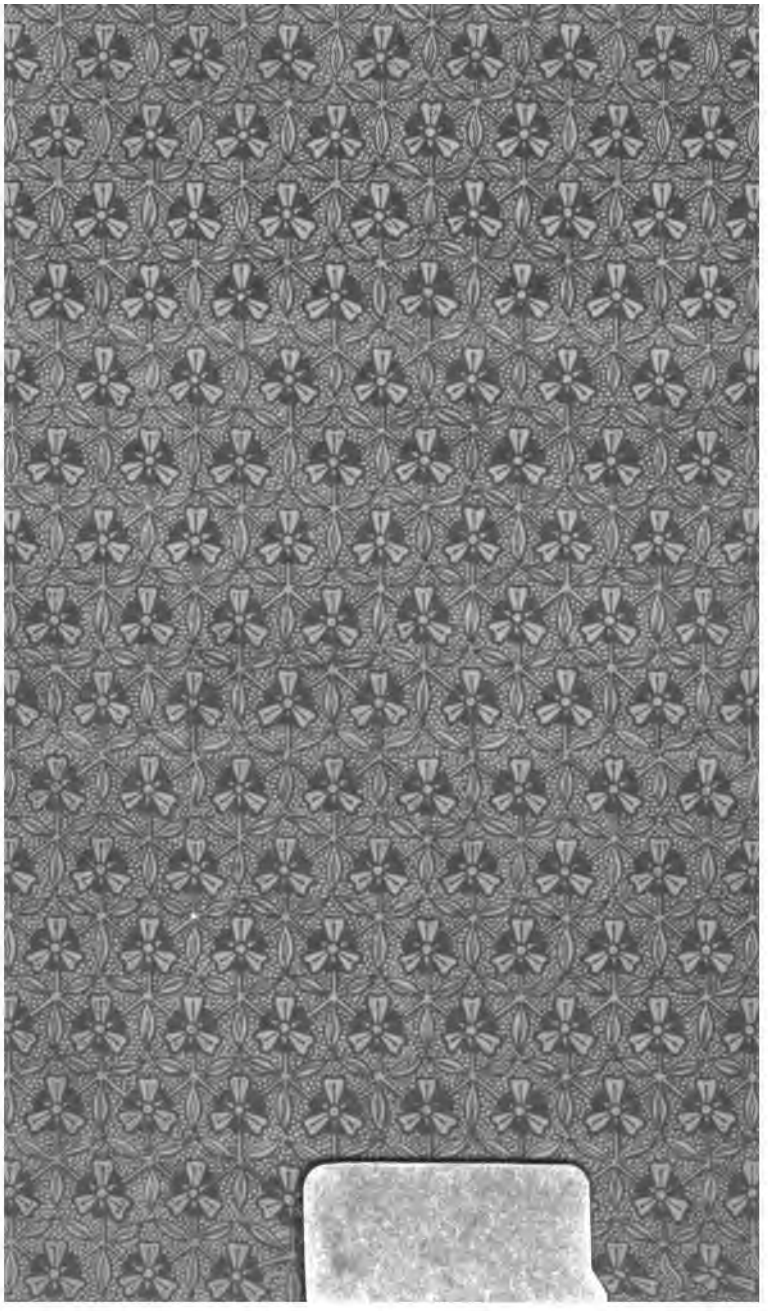
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